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Original Communications

DISSECTING ANEURYSM OF THE AORTA

A CLINICAL AND ANATOMICAL ANALYSIS OF NINETEEN CASES (THIRTEEN ACUTE) WITH NOTES ON THE DIFFERENTIAL DIAGNOSIS*

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INTRODUCTION

AN UNCOMMON but important vascular lesion that has received far too little attention clinically is partial rupture of the wall of the aorta with dissection of its coats, designated generally as dissecting aneurysm of the aorta. A recent experience with several cases has changed our attitude from one of remote academic interest in the pathological aspects of the subject to one of lively practical attention to the possibility of making an ante-mortem diagnosis. It is this experience and an analysis of the cases that have come to autopsy at the Massachusetts General Hospital in the last thirty-eight years that we shall present.

For many years the lesion has been well known to pathologists, having been recognized clearly for the first time by Maunoir[1] in 1802 and established on a firm foundation as a pathological entity by Peacock[2] in 1843. Shennan's recent comprehensive monograph on dissecting aneurysms[3] has made it unnecessary to give here a lengthy review of the literature on the subject.

Clinical observations in this condition have been, with few exceptions, incomplete, and the diagnosis has been made almost exclusively at post-mortem examination. For an explanation we have only to consider the conditions under which the majority of these patients are observed. The disease comes suddenly and often with such overwhelming severity that its victim dies in a short time or is rendered so ill that no accurate account of his symptoms can be obtained. Often in deference to a very sick patient the physician postpones the complete examination which may give valuable diagnostic leads. That the diagnosis is so rarely made

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clinically, being confused with various intrathoracic and intraabdominal conditions, notably coronary thrombosis, indicates the present need of further contributions to our knowledge of the subject. Almost every condition with which it is confused is less likely to be rapidly fatal than dissecting aneurysm of the acute type. Therefore, if for no other reason than to establish a more accurate prognosis, we should be on the alert for this condition. On the other hand, dissecting aneurysm may not be immediately fatal, even when extensive. Shennan cites case after case from the literature in which, at post-mortem examination, healing or organization had occurred with persistence of the dissected sac to a greater or lesser extent, and in only 2 of some 75 cases was the diagnosis made during life.

In his analysis of 300 cases of dissecting aneurysm of all types, including 17 of his own, Shennan considered the diagnosis as having been correctly made in 6 cases during life. These were made by Swaine[4] (1855-56), Bahrdt[5] (1872), Wyss[6] (1869), Davy and Gates[7] (1922), Moosberger[8] (1924), and Barton[9] (1930). Sampson[10] (1931) and Kellogg and Heald[11] (1933) have each reported additional cases in which the diagnosis was correctly made during life. Weiss[12] (1935), in a recent review of the clinical course of spontaneous dissecting aneurysm of the aorta, reports three cases personally observed, in one of which the condition was clinically recognized. Lounsbury[13] (1935) and Gurin and his coauthors[14] (1935) have also reported cases in which an antemortem diagnosis was made. There are probably others, besides these eleven cases, which have not come to our attention.

It has been our own unusual experience to encounter recently several cases of dissecting aortic aneurysm clinically, in two of which the diagnosis was made during life. One case of this group, diagnosed incorrectly as coronary thrombosis, has been reported in detail by two of us (P. D. W. and B. C.),[15] and another, diagnosed correctly, was referred to in a footnote of the same communication. During the preparation of this paper another case included herewith was observed and correctly diagnosed during life by one of our associates, Dr. William Paul Thompson. This brings the total number of cases recognized during life to thirteen or more,* excluding those cases referred to as traumatic in origin, of which there are a fair number in the literature.[10, 16, 17]

The present report is an analysis of the clinical and anatomical features of thirteen cases of dissecting aortic aneurysm directly related to the death of the patient and six cases found incidentally among 8,200

*Since this paper was written, five additional cases of acute dissecting aortic aneurysm, diagnosed ante mortem, have come to our attention. Four of these have been observed within the past few months by Dr. Soma Weiss (personal communication) at the Boston City Hospital and the fifth by Dr. Lewis A. Conner (personal communication) at the Staten Island Hospital in New York City. This brings the total number of cases correctly diagnosed ante mortem to eighteen or more.

necropsies of subjects of all ages at the Massachusetts General Hospital.* Hereafter, the former group will be referred to as "acute," the latter group as "incidental." The case histories and important autopsy findings are given in abstract form in Tables I and II. Appended to Table II is one case in which the intima of the descending branch of the left coronary artery was slit for a short distance, resulting in dissection and thrombus formation between the coats of the vessel. This was the only instance of a dissecting process in a smaller vessel in which there was not also aortic dissection. There was, however, no microscopic examination made in that case.

ANALYSIS OF TABLES

Frequency, Age, Sex, and Occupation

The actual frequency of acute dissecting aneurysm in our series was approximately one in 630 autopsies of all ages, or, if the 6 incidental cases are included, one in 430 autopsies. The former ratio is intermediate in position among the incidences recorded by various authors: Walker and Walker[18] 1:2,500; Ames and Townsend[19] 1:500 in patients of all ages; and Weiss[12] 1:300 in adults.

The thirteen acute cases reported here occurred in persons over forty years of age with one exception, a young man aged twenty-nine years, who had rheumatic aortic and mitral valve disease. Four patients were in the forties; five in the fifties; two over seventy; and one over eighty. All of the incidental cases were over fifty years old; one in the fifties; two in the sixties; and three over seventy. This is in accord with the age incidence reported in the literature.

Among the acute cases eleven were males and two were females; this is the usual incidence. There were four males and two females among the incidental cases.

Of the acute cases, eight patients had relatively sedentary occupations, five were of the laboring class.

Symptoms and Signs

The very sudden, definite onset of symptoms is one of the striking features of acute dissecting aneurysm. In only two of our thirteen acute cases were the symptoms of such gradual onset and development as to leave any doubt regarding the time of onset. In five, or nearly 40 per cent, a history was obtained of effort or excitement immediately preceding the onset of symptoms, which included stooping to pick up a heavy object in two cases, vomiting in one, sexual intercourse in one, and arguing a case in court in another.

Pain.—In the majority of the acute cases (nine), the pain originated above the diaphragm, less often in the abdomen or flank (four). But regardless of the origin of the pain, in no two cases in our series was

*Some of the cases recorded here have been reported separately from time to time in *The New England Journal of Medicine* under the "Case Records of the Massachusetts General Hospital." Since the present report includes all of the cases occurring at the Massachusetts General Hospital up to September, 1936, duplication can be avoided in future tabulations by not counting these individual case reports.

TABLE

THIRTEEN CASES OF ACUTE DISSECTING ANEURYSM OF THE

NO. (YEAR)	AGE	SEX (RACE)	OCCUPATION	HISTORY	PHYSICAL FINDINGS	COURSE	SURVIVAL AFTER ONSET
1 (1897)	40	M (C)	Waiter	Sharp pain across front of chest 4 days before entry, worse on taking a breath. Subsequent cough and dyspnea. Pain continued severely, mostly on the left side. Hoarseness from shortly after the onset.	Pale, slightly dyspneic; respirations, 32. Dull to flat on percussion over left back from angle of scapula to apex, with harsh breath sounds and numerous râles. Fine râles over the front of both lungs. Coarse râles over right back. Heart said to be normal. Rate 88. Blood pressure not taken.	Pain continued. No response to supportive treatment. Breathing became progressively more difficult and he died, the heart having been said to be normal ½ hour before death.	6 days
2 (1902)	42	M (W)	Architect	Sudden onset of sharp, agonizing pain in right lumbar region, constant for one week before entry, relieved only by large doses of morphia. No further history.	No examination made for stated reason that patient was in such great pain. Pulse, 100.	2½ hours after entry he sat up in bed crying out with pain, following which he lost consciousness, became cyanotic, and died within thirty minutes.	7 days

the radiation exactly the same. In three instances in which the pain originated substernally, there was no radiation in one; another had pain extending to both sides of the chest, more on the left; and in the third, the pain radiated through to the interscapular region, upward into the left jaw, and later down into the thighs. In two patients in whom the pain was described as "precordial" in origin, one had radiation of the pain into the back and right chest, and the other lateral radiation equally to the two sides of the chest. Of the four remaining patients in whom the pain originated above the diaphragm, one developed interscapular pain first, with radiation anteriorly to the region beneath the sternum; the second had initial pain in the right lower chest and flank, with a slight radiation to the right shoulder; the third had pain originat-

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AORTA DIRECTLY RELATED TO THE DEATH OF THE PATIENT

TEMPERATURE	LABORATORY DATA	CLINICAL DIAGNOSIS	PERTINENT AUTOPSY FINDINGS IN AORTA	ANATOMICAL DIAGNOSES
98-100° F.	Hgb., 33% (T.); R.B.C., 3,324,000; W.B.C., 20,800. Urine, small amount of albumin and numerous casts.	Bronchopneumonia. Chronic pleurisy. Diffuse nephritis.	Small sheath dissection on posterior portion of thoracic aorta at level of bifurcation of trachea, with small intimal opening 8 cm. from the arch, and rupture into mediastinum surrounding the trachea and esophagus. Slight arteriosclerosis of aorta. Microscopic examination negative for syphilis.	Ruptured dissecting aneurysm of aorta. Adhesive pericarditis. Hypertrophy of left ventricle. Chronic glomerular nephritis.
No data	No data	None made	Sheath dissection of media from median portion of arch downward for 7 cm., with rupture of adventitia into posterior mediastinum and retroperitoneal tissues. Intimal tear in arch (presumably). Also intimal tear in right iliac with small dissection. Moderate arteriosclerosis of aorta.	Dissecting aneurysm of thoracic portion of aorta with extensive hemorrhage into posterior mediastinum, subpleural, and retroperitonal tissues. Dissecting aneurysm, right common iliac artery. Hypertrophy of heart.

ing over the posterior aspect of the right shoulder, radiating to the left shoulder and thence down the anterolateral aspects of the chest, settling with greatest intensity in both lower abdominal quadrants; and the fourth had pain which began in the right ear and mastoid region, radiating down the neck to the whole back and chest, worse on the right. The last mentioned patient, incidentally, was the only one who complained at any time of pain in the arms, and this was of a vague aching nature associated with other vague pain throughout the thorax and trunk; in another patient, however, the left arm became numb and weak.

In three patients the pain began in the abdomen. In one of these, in whom there was total occlusion of the aorta just above its bifurcation, the radiation was described as being to the whole body, but particularly

TABLE I

NO. (YEAR)	AGE	SEX (RACE)	OCCUPATION	HISTORY	PHYSICAL FINDINGS	COURSE	SURVIVAL AFTER ONSET
3 (1917)	70	F (W)	Cook	On the day before entry, sudden onset of stabbing pain in interscapular region radiating through to lower part of sternum, occurring intermittently, but with a constant dull ache in between attacks of sharp pain. Dyspnea and orthopnea. Vomiting shortly after onset.	Obese. Râles at left lung base. Heart enlarged both to the right and left. Increased supracardiac dullness (8 cm.). Heart sounds of fair quality, rhythm irregular, rate 100. Short presystolic murmur at the apex. Blood pressure 260/140. Edema over the shins.	Improved somewhat with rest, digitalis, and the nitrites. Pain ceased after the 17th day, and she was discharged on the 37th day. Nine weeks later (15 weeks after initial attack), following vomiting after each meal for 3 days, she was taken suddenly with agonizing substernal pain radiating through to the back and died 9 hours later, shortly after her second admission to the hospital, and before any pertinent observations were made.	105 days after formation of dissecting aneurysm, 9 hours after its rupture.
4 (1917)	53	M (W)	Laborer	On the day before entry, while on a ladder bending over to fix a pipe, he was suddenly seized with severe stabbing pain in the left chest, just below and outside the nipple. The pain quickly increased in intensity radiating to the back and right chest, was worse on lying down, and was associated with great dyspnea. He was given cathartics and enemas without relief and later sent to the hospital.	Obese. Anxious facies and in great distress from substernal pain. Few râles at left lung base in front. The apex impulse of the heart was neither seen nor felt. The apical heart sounds were quite faint; no sounds were audible at the base. The rhythm was regular, the rate, 120. Questionable systolic murmur at the apex. Blood pressure, 190/120. Slight peripheral arteriosclerosis. Extreme epigastric tenderness. Reflexes normal. Respirations, 35.	Agonizing seizures of pain, as described, continued on slight movement or spontaneously. Became hoarse and later lost his voice entirely. Dyspnea was marked. B. P. fell to 100/78 after venesection, and there was partial syncope. Intractable distention developed and a "surgical abdomen" was considered. Though apparently in extremis his B. P. remained elevated (160) and the pulse fairly strong until 1 hour before death on the 6th day.	6 days

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TEMPERATURE	LABORATORY DATA	CLINICAL DIAGNOSIS	PERTINENT AUTOPSY FINDINGS IN AORTA	ANATOMICAL DIAGNOSES
99-100.8° F.	Hgb., 80% (S.); W.B.C., 13,000-15,000. Wassermann, negative. Urine, low Sp. G., trace of albumin. X-ray (7 ft. chest plate) on 19th day after onset. Interpretation: Well-marked cardiac enlargement. Great vessels measured 11.6 cm. Aneurysm of descending aorta (type not specified).	Angina pectoris. Arteriosclerosis. Chronic nephritis. N.B.—Apparently the x-ray diagnosis was not given much consideration.	Irregular cleft in intima at junction of arch and thoracic portion with sheath dissection of the media, proximally to the right coronary mouth and distally to a point 9 cm. below the arch. Rupture into mediastinum and retropleural spaces. Marked atheroma of aorta. Microscopic examination negative for syphilis.	Dissecting aneurysm of aorta with great hemorrhage into periaortic and retropleural spaces. Hemopericardium. Arteriosclerosis.
100-100.5° F. with gradual return to normal.	Hgb., 90% (S.); W.B.C., 18,500; N.P.N., 56 mg. %. Urine, slight trace of albumin, few casts. P.S.P. excretion, 35%. Wassermann, negative. Stool, positive guaiac test on 2 occasions. X-ray of chest on 5th day showed heart and great vessels much enlarged, and an area of dullness in the right mid-chest. The film was regarded as unsatisfactory, and a 2nd one taken post mortem was also unsatisfactory.	Pneumonia. Chronic nephritis. Arteriosclerosis. ? Aneurysm. ? Subdiaphragmatic abscess.	Elongated crevice in aortic intima at junction of arch and ascending portion in the region of an arteriosclerotic ulcer with sheath dissection of the media of irregular contour extending down as far as the inferior mesenteric artery; rupture into the mediastinum and both pleural cavities. Moderate arteriosclerosis of the aorta, in some places marked. Microscopic examination: Levaditi stain negative although there was some suggestion of syphilis in the aorta.	Dissecting aneurysm of aorta with extensive hemorrhage into pleural and pericardial tissues and pleural cavities. Hypertrophy of heart. Arteriosclerosis. Edema of lungs.

TABLE 1

NO. (YEAR)	AGE	SEX (RACE)	OCCUPATION	HISTORY	PHYSICAL FINDINGS	COURSE	SURVIVAL AFTER ONSET
5 (1921)	29	M (W)	Carpenter	Seven weeks before entry sudden onset of severe pain in right ear and mastoid region radiating down over back of neck. Pain was sharp in character and quickly spread over whole back and chest, worse on the right side and on deep inspiration. Intense dyspnea. Sat up for 48 hours gasping for breath. Continued orthopneic. Some edema, cough, and night sweats. On 5 occasions a total of 200 oz. of fluid removed from left pleural space, the last tap being bloody. These taps were done before his entry to M. G. H.	Apprehensive. Marked orthopnea. Head jerked with each heartbeat. Mucous membranes pale and cyanotic. Marked pulsation of great vessels. Well-marked Corrigan and capillary pulses. Signs of fluid in left chest. Heart greatly enlarged, rhythm regular, rate 115, diffuse heaving impulse. Systolic and diastolic murmurs at apex and base. Blood pressure, 170/20.	Continued apprehensive, complaining of aching pains in thorax, shoulders, face, and left arm. On the 9th day after entry, without warning sign or symptom, he fell back dead.	56 days
6 (1927)	84	F (C)	Housewife	Indigestion (dysphagia, gas, occasional vomiting) for one year. For 2 weeks had been able to take only liquids. For 1 week had complained of aching pain in the right flank and lower thorax without relation to breathing. Some dyspnea on effort.	Emaciated. Marked arcus senilis. Poor chest expansion. Lungs hyperresonant and clear. Heart slightly enlarged to left, rhythm regular, rate 80, sounds of fair quality. Loud systolic murmur over left precordium. Radial and brachial artery walls thickened. Pulse of poor volume. Blood pressure 60/40. Irregular liver edge 4 cm. below costal margin. Respirations, 25.	Continued to complain of pain as previously described. Also complained of some pain in the right shoulder and of a burning sensation high in the epigastrium. She was found dead by a nurse 18 hours after admission.	7 days

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TEMPERATURE	LABORATORY DATA	CLINICAL DIAGNOSIS	PERTINENT AUTOPSY FINDINGS IN AORTA	ANATOMICAL DIAGNOSES
Normal during period of observation. Temperature at onset not known.	R.B.C., 5,300,000; W.B.C., 7,000 (7 wk. after onset). Blood smear, normal. N.P.N., 31.5 mg. %. Urine, normal. P.S.P. excretion, 40%. Left thoracentesis on day before death yielded fluid, studies on which were inconclusive.	Rheumatic heart disease. Aortic insufficiency. Mitral insufficiency. Hydrothorax (left). ? Pericarditis. ? Pulmonary embolism.	Intimal and underlying medial degeneration in ascending portion of aorta, 5 cm. in length and from 4 mm. to 2 cm. in width. Short medial dissection and irregular perforation through adventitia into pericardial cavity. Descending thoracic and abdominal portions negative. Microscopic examination: Colloid degeneration of the media. No evidence of syphilis.	Degeneration of wall of ascending aorta with old and recent ruptures. Hemopericardium. Chronic endocarditis of mitral and aortic valves. Chronic adhesive pericarditis. Hypertrophy of heart.
99.2-100.2° F.	Hgb., 65% (T.); R.B.C., 4,176,000; W.B.C., 12,600. Blood smear, normal. N.P.N., 45 mg. %. Wassermann, negative. Stool, negative.	Arteriosclerosis, general. Arteriosclerotic heart disease.	Rupture of intima 4 cm. in length and 1.5 cm. above base of aortic valve. Medial dissection posteriorly with rupture into pericardium. Extensive calcified atheromatous plaques throughout aorta, some showing ulceration. Microscopic examination negative for syphilis.	Dissecting aneurysm of aorta (ruptured). Hemopericardium. Arteriosclerosis.

TABLE I

NO. (YEAR)	AGE	SEX (RACE)	OCCUPATION	HISTORY	PHYSICAL FINDINGS	COURSE	SURVIVAL AFTER ONSET
7 (1930)	51	M (W)	Teacher	Onset sudden on day of entry with terrific but rather dull pain over entire lower abdomen quickly spreading to both legs, chest, and shoulders. Desire to move bowels. Went to bath room twice unassisted. Within 10 minutes was paralyzed from waist down. Numbness began in feet and rapidly ascended to a point just above the symphysis pubis. Chest and shoulder pain quickly disappeared, but lower abdominal pain persisted.	Pale, ashen cyanosis. In much pain across lower abdomen. Complete flaccid paralysis both legs. Feet and lower legs waxy white and cold. Skin above this to level of symphysis pubis bluish red and cool. No dorsalis pedis or femoral artery pulsations on either side. Systolic and diastolic murmurs all over precordium, loudest at base. Blood pressure 220 systolic (140 soon after onset of symptoms). Abdomen not rigid or tender. Sensation and reflexes absent in lower extremities. Tendon jerks in arms present. Pulse, 90-120. Respirations, 20.	Death occurred on the operating table during the course of a proposed iliac embolectomy 9 hours after the onset of symptoms. The blood pressure fell gradually from 190/90 to 80/60 during the course of the operation.	½ day

to both legs, to the upper chest, and to both shoulders. Another developed epigastric pain which later became generalized over the abdomen and was associated with some substernal distress. In a third, the description was that of vague abdominal pain, worse across the upper abdomen on deep breathing. Only one patient complained of pain in the right lumbar region without radiation.

The character of the pain as described was for the most part severe and sharp or stabbing. However, it was variously described as at first dull, but later severe, constricting and penetrating; terrific but dull; oppressive; aching and vague. One patient, a physician, who described his symptoms quite accurately, likened the onset in its severity to the blow of a sledge hammer on the chest.

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TEMPERATURE	LABORATORY DATA	CLINICAL DIAGNOSIS	PERTINENT AUTOPSY FINDINGS IN AORTA	ANATOMICAL DIAGNOSES
100.2° F.	No data	Embolism, iliac arteries (bilateral).	T-shaped tear in intima 1.5 cm. above right posterior aortic cusp with sheath dissection of media of the whole aorta to 4 cm. above its bifurcation where a massive clot within the wall of the vessel occluded the lumen. Microscopic examination negative for syphilis.	Dissecting aneurysm of aorta. Arteriosclerosis. Aortic valve stenosis (calcareous).

In eleven out of the thirteen patients the pain was more or less constant from its inception until death occurred. The remaining two were relieved after a few hours by morphia.

In seven patients in whom the effect of respiration on the pain was known, it was made worse in four, and in three there was no effect.

Dyspnea was present in eight out of nine cases in which this symptom was noted.

The degree of *prostration* and apparent *shock* is extreme in most cases, yet the blood pressure may be maintained at a very high level. Loss of consciousness is common, and in those in whom this does not occur the suffering is so intense that often little information can be obtained from them regarding the details of their illness.

TABLE I

NO. (YEAR)	AGE	SEX (RACE)	OCCUPATION	HISTORY	PHYSICAL FINDINGS	COURSE	SURVIVAL AFTER ONSET
8 (1932)	54	M (W)	Lawyer	History of slowly advancing hypertension with renal involvement for 15 years. On day of entry awoke with dull pain over precordium. At 11 A.M., while trying a case in court, was suddenly seized with severe constricting and penetrating pain over left lower chest in front, extending to right of chest, associated with weakness and numbness of entire left arm. He was brought to the hospital in a state of collapse.	Pale, apprehensive. Reflexes normal. Lungs clear. Heart moderately enlarged, rhythm regular, rate 90, sounds of good quality. Aortic second sound slightly exaggerated, slight aortic systolic murmur. No edema. Blood pressure, 200/100. Respirations, 20.	Blood pressure remained elevated (210/135-120) for 3 days, then fell gradually to 160/100. Vague upper and mid-abdominal pain continued more or less constantly, but he appeared to be doing fairly well until his sudden death on the 8th day after the onset of symptoms.	8 days

Hypertension is almost invariably present. It was found in eight out of eleven of our acute cases, in which the blood pressure was determined. Four who were known to have had preexisting hypertension maintained the hypertension to a greater or lesser degree after dissection of the aorta took place; in one of these, a man aged twenty-nine years, aortic insufficiency of rheumatic origin was present. In three patients of whom we had no previous knowledge of the blood pressure, hypertension was present shortly after the onset of the acute attack, falling off gradually, but later in two of these, attaining a higher level again before death occurred. One patient, in whom the aorta was totally occluded near its bifurcation, developed in the period of one hour a systolic pressure of 220 mm. of mercury, the original pressure being 140 mm. of mercury. In this case the diastolic pressure was never greater than 90. In one patient the blood pressure was normal when first deter-

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TEMPERATURE	LABORATORY DATA	CLINICAL DIAGNOSIS	PERTINENT AUTOPSY FINDINGS IN AORTA	ANATOMICAL DIAGNOSES
99-100° F.	W.B.C., 19,000-16,400. Wassermann, negative. Electrocardiogram, within normal limits on 3 occasions (1st, 2nd, and 5th days after entry).	Coronary thrombosis.	Horizontal intimal tear, almost complete, 7 cm. below arch, and partial horizontal tear 3.5 cm. below arch; also 2 ulcerations with perforation, one at junction of arch and descending portions, the other 2.5 cm. below this. Almost complete sheath dissection of descending thoracic aorta beginning at distal portion of arch and partial dissection for 6 cm. below this with a sac of the following dimensions (6 by 1 by 0.2 cm.) extending into both common iliac arteries. Rupture into mediastinum and right pleural cavity. Moderate arteriosclerosis of aorta. Microscopic examination negative for syphilis.	Dissecting aneurysm of aorta and iliac arteries. Rupture of descending thoracic aorta. Hemothorax (right). Hypertrophy of heart. Arteriosclerosis. Acute endocarditis of mitral and aortic valves.

mined a few weeks after the onset, and fell off gradually. Two patients had very definitely low pressures when seen in the acute attack, but there was good reason to believe, in these instances as in the majority of cases, that the blood pressure had been elevated. In small dissecting aneurysms occurring as incidental findings at autopsy, the incidence of hypertension was equally high, being present in four out of five of our cases in which the blood pressure was recorded.

The *pulse rate* in more than one-half of the cases (seven) was between 80 and 104 per minute. In one case the pulse rate was 70; in one, 110; and in the remaining four, 120 to 140. In those with higher initial pulse levels who lived for several days, the rate came down gradually. In only three cases was there a positive or negative statement regarding the peripheral pulsations other than the radial pulses. In all of these cases symptoms and signs were present directing attention to the lower

TABLE I

NO. (YEAR)	AGE	SEX (RACE)	OCCUPATION	HISTORY	PHYSICAL FINDINGS	COURSE	SURVIVAL AFTER ONSET
9 (1932)	44	M (W)	Laborer	Previous history of hypertension of unknown duration. Choking sensations with slight pain in upper chest, occurring at rest for 5 months. Blood pressure known to be 220/116 for 8 weeks. While sitting on bench in clinic waiting to be seen, he was suddenly seized with a severe sense of oppression in the chest, perspired freely, and became very dyspneic. There was a sense of impending death and great weakness. He was admitted to the hospital at once.	Slight cyanosis of the lips. Moderate respiratory distress (after morphia). Slight sclerosis of optic vessels. Marked left precordial bulge. Moderate enlargement of heart, rhythm regular, rate 90, sounds of fair quality. Loud systolic, and moderately loud short diastolic murmurs heard over base of heart (these had been noted 8 weeks previously). Blood pressure, 210/100. Lungs clear.	Responded to morphia but remained weak and perspired freely. A few hours later he suddenly became very cyanotic, lost consciousness, and died.	4 hours
10 (1934)	57	M (W)	Physician	Known hypertension for several years. Onset sudden while picking up box from floor. Severe substernal pain, coming abruptly like the blow of a sledge hammer, radiating into back between the shoulder blades, into the left upper jaw, and later into thighs, lasting about 5 hours in spite of morphia.	Slightly ill, heart moderately enlarged, sounds of good quality, aortic 2nd sound accentuated, soft systolic murmur at apex and base, very slight early diastolic murmur all along left sternal border. Pulse full and soft, rate 70. Dorsalis pedis arteries well felt. Blood pressure, 140/100. Knee jerks, normal.	He remained fairly comfortable with morphia, but died suddenly on the third day while talking to a friend.	2 days

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TEMPERATURE	LABORATORY DATA	CLINICAL DIAGNOSIS	PERTINENT AUTOPSY FINDINGS IN AORTA	ANATOMICAL DIAGNOSES
No data	Hinton reaction, negative. X-ray, 7 foot plate, 8 weeks before onset showed hypertrophy of heart to the left and dilatation of ascending aorta.	Hypertensive heart disease. Aortic insufficiency (relative). Cardiac asthma.	Saw-toothed intimal tear 2 cm. in length, 1 cm. above aortic valve on posterior wall with sheath dissection involving ½ of circumference of aorta posteriorly extending the whole length of the aorta, distally into the iliacs and proximally to the aortic ring. The dissection involved also the whole innominate artery and extended for 3 cm. along the left subclavian artery. Microscopic examination showed cystic degeneration of the media (medionecrosis aortica cystica) with only the muscle layer affected. Rupture into pericardium. No evidence of syphilis.	Dissecting aneurysm of aorta (ruptured). Hemopericardium. Medionecrosis aortica cystica. Hypertrophy of heart.
100° F.	W.B.C., 18,000. Electrocardiogram (on 2nd day), normal rhythm, rate 100, low T_1, flat T_2, high origin with slight late inversion of T_3, inverted P_3 and QRS_3.	? Dissecting aneurysm of aorta. ? Coronary thrombosis.	Longitudinal tear 3 cm. in length just above posterior aortic cusp with sheath dissection involving three-fourths of the circumference of the aorta posteriorly and extending its entire length into iliacs, into innominate, and proximally involving the right coronary orifice.	Dissecting aneurysm of aorta involving iliacs, innominate, and right coronary arteries.

TABLE 1

NO. (YEAR)	AGE	SEX (RACE)	OCCUPATION	HISTORY	PHYSICAL FINDINGS	COURSE	SURVIVAL AFTER ONSET
11 (1935)	70	M (W)	Retired	Weakness and vague abdominal pain of six weeks' duration. No other details of history available.	Emaciated and appeared quite weak and ill. Mentally confused. Sclerotic fundi. Heart greatly enlarged, action forceful, rate 130, rhythm regular, loud systolic murmur at apex and aortic area. Second sound of poor quality. Respirations, 30; râles at both lung bases. Abdomen distended, poorly localized tenderness in RLQ near the midline. Blood pressure, 144/100.	He failed rapidly, sinking into stupor from which he could not be aroused. The blood pressure fell to a point that could not be determined. The chest filled with large râles and he died on the third day after admission.	? 42 days. Onset indefinite.
12 (1935)	52	M (W)	Laborer	Incomplete. Known to have had generalized abdominal pain with nausea and vomiting for three days before entry. Also subsequently some precordial pain. On account of a distended tender abdomen, he was sent to the hospital for surgical consideration. No record of blood pressure before entry.	Acutely ill, pulse 140, temperature 101.6° F., respirations, 34. Heart and lungs said to be normal. Blood pressure, 100/60. Abdomen very stiff and generally tender but not more on one side than on the other. Reflexes normal.	Before an exploratory laparotomy could be done, he went into shock, blood pressure falling to 40 systolic. He sank rapidly into coma and died in spite of a transfusion and other intravenous therapy. He could not void, and no urine was obtained by catheter.	3 days

extremities. In two of them, the preoperative diagnosis of iliac embolism was made, and surgery was resorted to in an attempt to relieve the arterial obstruction.

Of twelve cases the *heart sounds* were good in seven, fair in four, poor in one. *Heart murmurs* of various types were present in ten of twelve

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TEMPERATURE	LABORATORY DATA	CLINICAL DIAGNOSIS	PERTINENT AUTOPSY FINDINGS IN AORTA	ANATOMICAL DIAGNOSES
98-101.2° F.	Hgb., 60% (T.); R.B.C., 3,850,000; W.B.C., 30,000. N.P.N., 87 mg. %. Blood sugar, 130 mg. %. Urine, very slight trace of albumin, occasional R.B.C. in sediment.	Chronic nephritis. Uremia.	3 cm. tear in intima opposite renal arteries with sheath dissection downward for 8-10 cm. Slightly below intimal tear is a rupture of the adventitia with much extravasated blood invading all tissues and cleavage planes in vicinity and extending upward through diaphragm into right pleural cavity. Extensive arteriosclerosis of aorta from above downward. Microscopic examination negative for syphilis.	Dissecting aneurysm of abdominal aorta (ruptured). Hemothorax, right. Arteriosclerosis, general. Cardiac hypertrophy. Calcification of aortic valve.
101.6° F.	W.B.C., 17,400 to 34,000 (terminal). X-ray film of the abdomen gave no significant information.	General peritonitis probably due to ruptured appendix.	4 cm. transverse tear in intima 1.5 cm. above aortic ring with sheath dissection of entire aorta (complete for 3.5 cm. just distal to celiac axis) extending down to iliacs and proximal dissection with hemorrhagic infiltration into myocardium around right coronary orifice. No external rupture. Microscopic examination negative for syphilis.	Dissecting aneurysm of thoracic and abdominal aorta. Hemorrhage, aortic, into myocardium about right coronary artery.

cases. In three of these there was significant valvular disease—the young man, aged twenty-nine years, with rheumatic heart disease referred to previously, and two older patients with calcareous changes in the aortic valve. Aside from the case of rheumatic heart disease in which there were both systolic and diastolic murmurs at the apex and

TABLE I

NO. (YEAR)	AGE	SEX (RACE)	OCCUPATION	HISTORY	PHYSICAL FINDINGS	COURSE	SURVIVAL AFTER ONSET
13 (1935)	44	M (W)	Salesman	Sudden onset, while walking, of severe pain over posterior aspect of right shoulder, which within two minutes coursed across his back to a similar location on the left shoulder, then down the anterolateral aspects of his chest on both sides, down the sides of his abdomen, where it finally settled and remained with greatest intensity in both lower abdominal quadrants. The legs became numb and cold; the skin over them blue; and the slightest movement caused great pain in the right leg.	Obese. Unable to walk. Moderate degree of shock. Marked cardiac enlargement. Heart action regular at rate of 104, sounds of fair quality, blowing systolic murmur at apex. Blood pressure, 190/110. Lungs clear. Abdomen tympanitic. Both legs cold at first; several hours later the left leg became warm again. No pulsations could be felt in the right leg, and they were weaker than normal in the left leg. The right leg was without sensation from the hip down.	A diagnosis of embolism of the right common iliac artery was made sixteen hours after the onset. A clot 3 inches in length was removed from the right common iliac artery, but blood failed to flow from the proximal segment. His condition was poor following operation; blood pressure, 100/50. He developed pulmonary edema and died 36 hours after the onset of symptoms.	1½ days

base, the most common murmurs were systolic and diastolic combined over the base of the heart (noted three times). In one of these, aortic stenosis of calcareous origin was present. In another a diastolic murmur had been noted eight weeks previous to the onset of symptoms. Presumably in the third the diastolic murmur was the result of sudden altered conditions in the aortic ring, or as suggested by Resnick and Keefer,[20] may have been the result of the same factors which produce murmurs in arteriovenous aneurysm. A systolic murmur alone over the base of the heart was heard in two cases, and a systolic murmur at the apex in three; a diastolic murmur at the apex, in a man aged seventy years, is perhaps to be explained on the basis of left ventricular dilatation.

Hoarseness occurred in two of our thirteen acute cases. In both there was rupture of the dissecting aneurysm with hemorrhage into the mediastinum.

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TEMPERATURE	LABORATORY DATA	CLINICAL DIAGNOSIS	PERTINENT AUTOPSY FINDINGS IN AORTA	ANATOMICAL DIAGNOSES
No data	None reported except for total hematuria in a catheter specimen of urine taken on arrival at the hospital.	Right iliac embolism (by surgical service). Dissecting aortic aneurysm (by cardiac consultant).	Transverse tear 5 cm. in length, 10.5 cm. from aortic valve at junction of arch and descending portion. Media is dissected by a homogeneous blood clot, the separation involving only the posterior and lateral aspects of the aorta. Short dissection (8 mm.) into media of left renal artery. On the right the dissection stops 7 cm. above the bifurcation of the aorta; on the left it continues down into the left common iliac artery for 3.5 cm. where it ruptured through the intima into the lumen again. Moderate atheromatous change throughout entire course of descending aorta. Microscopic examination negative for syphilis.	Dissecting aneurysm of thoracic and abdominal aorta; partial dissection of renal and common iliac arteries. Cardiac hypertrophy, hypertensive type. Pulmonary edema. Gastric ulcers.

In eleven cases with adequate examination there were seven with no significant signs over the lungs. Two patients had signs interpreted as pneumonia; both of these had hemorrhage into the mediastinum, and one into the pleural cavities as well. In one patient who survived for fifty-six days after the onset, left hydrothorax was present.

A low grade *fever*, with the temperature ranging from 99° to 101.6° F., was present in all cases for a few days following the onset.

Survival After Onset

In ten (76 per cent) of our thirteen acute cases, the survival after the onset of symptoms was 6, 7, 6, 7, ½, 8, ½, 2, 3, and 1½ days, respectively, an average of 4.15 days. Of the remaining three cases (24 per cent), one lived for 105 days after the formation of the dissecting aneurysm and died suddenly twelve hours after its rupture. Another

TABLE II

SIX CASES OF DISSECTING ANEURYSM OF THE AORTA FOUND INCIDENTALLY AT AUTOPSY, AND ONE CASE OF DISSECTING ANEURYSM OF A CORONARY ARTERY

NO. (YEAR)	AGE	SEX (RACE)	OCCUPATION	HISTORY	PHYSICAL FINDINGS	COURSE	CLINICAL DIAGNOSIS	PERTINENT AUTOPSY FINDINGS	ANATOMICAL DIAGNOSES
14 (1909)	52	M (W)	?	No history suggestive of dissecting aneurysm. Hemiplegia 3 days before entry.	Heart enlarged, rate rapid, rhythm irregular, sounds of poor quality. Blood pressure, 200 systolic.	Gradual downhill course, coma, and death on the third day after entry with a terminal temperature of 100° F.	Cerebral hemorrhage. Hypertension.	In the thoracic aorta near the third left intercostal artery a 5 mm. opening in the intima admitted a probe into a small pouch the outer covering of which was adventitia. No perforation. Marked arteriosclerosis of aorta. Microscopic examination negative for syphilis.	Small dissecting aneurysm of aorta. Cerebral hemorrhage. Arteriosclerosis, general. Cardiac hypertrophy.
15 (1916)	75	M (W)	?	Health allegedly good up to present illness. Right renal colic for one week before entry.	Recorded as negative except for tenderness and spasm in the right flank. Bladder stones found on cystoscopy. No record of blood pressure.	Did very poorly. On 27th hospital day he had a cerebral hemorrhage with left hemiplegia and died.	Cerebral hemorrhage. Nephrolithiasis.	Medial dissection of left side of aorta forming a separate healed sac extending from the isthmus along the left side of aorta and opening into the left common iliac artery at a	Healed dissecting aneurysm of aorta. Arteriosclerosis. Cardiac hypertrophy. Ureterolithiasis. Cholelithiasis. (Cerebral hemorrhage.)

TABLE II—CONT'D

								point just where it is given off from the aorta. The sac varied in circumference from 8.5 to 2 cm. and was 1 cm. in diameter at its outlet into the iliac artery. It contained blood. Both the aorta and the sac showed fibrocalcareous changes. Microscopic examination negative for syphilis.	
16 (1921)	66	M (W)	Metal worker	No cardiovascular history.	Heart normal in size, shape, and sounds, except for a slight systolic murmur. Pulse rate, 100. Blood pressure, 140/76. Moderate peripheral arteriosclerosis.	Died on 4th day after operation. (Posterior gastroenterostomy.)	Carcinoma of stomach. Pulmonary edema.	Perforation of atheromatous patch at isthmus with splitting and separation of the wall with blood for a very short distance. Moderate arteriosclerosis of aorta. Microscopic examination negative for syphilis.	Small dissecting aneurysm of arch of aorta. Arteriosclerosis. Carcinoma of stomach. Pulmonary edema.

TABLE II—CONT'D

NO. (YEAR)	AGE	SEX (RACE)	OCCUPATION	HISTORY	PHYSICAL FINDINGS	COURSE	CLINICAL DIAGNOSIS	PERTINENT AUTOPSY FINDINGS	ANATOMICAL DIAGNOSES
17 (1921)	65	F (W)	Housekeeper	Coronary heart disease with angina pectoris and several episodes of congestive failure over a period of 7 years. Also paralysis agitans.	Obese. Large heart. Auricular fibrillation. Anasarca. Blood pressure, 185/100.	Died on 3rd day after entry from congestive heart failure.	Arteriosclerotic heart disease. Hypertension. Angina pectoris. Arteriosclerosis, general. Paralysis agitans.	Atheromatous patch in the lower part of the arch, at the base of which there is a small area where the adventitia is dissected for a short distance. The small adventitial sac is intact and contains blood. Marked arteriosclerosis of aorta. Microscopic examination negative for syphilis.	Small dissecting aneurysm of aorta. Arteriosclerosis, general. Cardiac hypertrophy.
18 (1923)	72	M (W)	Auditor	Fell, striking head on sidewalk 10 days before entry. Unconsciousness for a short time thereafter, followed by headache and gradually increasing weakness.	Cyanotic. Large heart. Blood pressure 190/110. Slight left hemiplegia.	Gradually sank into deep coma and died.	Cerebral hemorrhage. Bronchopneumonia.	2 cm. crevice in an atheromatous area just above bifurcation of aorta opening into the cavity of a dissecting aneurysm which extends downward into the common iliac artery for 9 cm. Moderate arteriosclerosis of aorta. Microscopic examination negative for syphilis.	Small dissecting aneurysm of abdominal aorta. Chronic internal pachymeningitis with extensive hemorrhage. Arteriosclerosis. Cardiac hypertrophy.

TABLE II—CONT'D

19 (1925)	74	F (W)	Housewife	Several attacks of acute gallbladder colic. Admitted for operation.	Obese. Jaundiced. Heart slightly enlarged. Poor sounds. Blood pressure 170/90.	Developed pulmonary edema and died on the 4th day after operation. (Cholecystectomy.)	Acute cholecystitis. Cholelithiasis.	Fibrocalcareous patch 1.5 cm. in diameter in arch, at the base of which there is a small, dissecting aneurysm. Periadventitial tissues slightly infiltrated with blood. Moderate arteriosclerosis in remainder of aorta. Microscopic examination negative for syphilis.	Small dissecting aneurysm of lower end of aortic arch. Arteriosclerosis. Cardiac hypertrophy. Cholecystitis with necrosis of bladder wall. Cholelithiasis.
20 (1902)	51	M (W)	?	Slowly advancing myocardial insufficiency for 10 years, worse for 6 months prior to entry. No history of chest pain.	Large heart, forceful. Gallop rhythm. Aortic 2nd sound accentuated. Dependent portions of body everywhere edematous. No record of blood pressure.	Failed rapidly and died on 5th day after entry of congestive heart failure.	Arteriosclerotic heart disease. Congestive heart failure.	Small slit 4 mm. long in descending branch of left coronary artery containing a thrombus between the coats of the vessel. Microscopic examination not reported.	Dissecting aneurysm descending branch of left coronary artery. Cardiac hypertrophy. Right auricular and right and left ventricular thrombi. Subacute glomerular nephritis.

lived 56 days after the onset of symptoms and then died suddenly. In the third case the actual time of onset was uncertain, but the onset probably took place about thirty-six days before death occurred.

At this point, one case among those found incidentally at autopsy deserves special mention. It is an instance of the so-called "double-barreled aorta" in a man aged seventy-five years, who admitted no previous serious illness, although a detailed past history was not taken. He entered the hospital because of renal colic, and stones were found in the urinary bladder. He died on the twenty-seventh day following a cerebral hemorrhage. For details of the changes in his aorta, see Table II, Case 15.

Cause of Death

In six of our thirteen acute cases, death was the result of rupture into the mediastinum with or without extension into the pleural or retroperitoneal spaces. Rupture into the pericardium occurred in four cases. One patient died from complete occlusion of the aorta near its bifurcation without rupture; in another there was rupture back into the lumen of the aorta, death resulting from shock and pulmonary edema; while in the thirteenth case the death was due to complete anuria of unknown cause. In this last case there was dissection in the region of the renal arteries, but they were apparently not directly involved, and there was no rupture.

Of the six incidental cases, death was due in three to cerebral hemorrhage, in one to coronary heart disease, in one to carcinoma of the stomach, and one patient died postoperatively, following a cholecystotomy.

Laboratory Data

The *white blood cell count* in eight acute cases averaged 20,000, with extremes of 12,600 and 34,000. An additional patient seen six weeks after the onset had a count of 7,000 which remained at this level. In extensive dissections, or when rupture occurs, the red blood cell count falls.

The Wassermann or Hinton reaction was determined in nearly one-half (6) of the acute cases and in two-thirds (4) of the incidental cases and was always found to be negative.

Electrocardiograms were taken in only two of our thirteen acute cases. In one of these in which the clinical diagnosis was coronary thrombosis, the tracings were essentially normal on the first, second, and fifth days. On the eighth day, when apparently improving, the patient died suddenly. The other case, following shortly after the one just mentioned, was correctly diagnosed on the basis of the clinical characteristics of his illness though the electrocardiogram showed slight T-wave changes in Leads II and III, suggestive of cardiac infarction of the posterior or diaphrag-

matic type. The probable reason for the slight abnormality was revealed when at autopsy the aortic dissection was found extending proximally to involve the opening of the right coronary orifice.

X-ray examinations were made in three cases. In one of these a diagnosis of aneurysm of the descending aorta (type not specified) was made by the roentgenologists, but the possibility of a dissecting aneurysm was entirely overlooked by the clinicians. This patient lived for more than three months after the formation of the dissecting aneurysm and then died within a few hours after it had ruptured. In a second case, the aortic arch on the left was reported as prominent, but the interpretation was equivocal. Here, rupture had occurred into the mediastinum and both pleural cavities. A third patient had a flat x-ray plate of the abdomen to determine the presence of gas beneath the diaphragm, but this gave no important information. Dissection was present in the thoracic and abdominal aorta.

PATHOLOGY, ETIOLOGY, AND PATHOGENESIS

The aorta often shows a transverse, irregular tear from 1.5 cm. to 2 cm. in length and about 1.5 cm. above the valve ring. This tear extends through the intima and part way through the media into which blood penetrates until it finds a plane of cleavage and begins to dissect. The dissection lies almost always between the middle and outer thirds of the media, involves about one-half or two-thirds of the circumference of the vessel, and extends distally along the greater part or the entire course of the aorta, quite often into the iliac arteries, less often into the vessels of the arch, and only rarely into the renal or other smaller branches. Occasionally the blood dissects backward down to the valve ring to impinge upon one of the coronary mouths. This occurred in two of our cases (Cases 10 and 12, Table I) and in one apparently produced anginal pain. In Case 7, Table I, the aneurysm compressed the lumen of the abdominal aorta 4 cm. above the bifurcation, with subsequent paralysis of the lower extremities.

The blood enclosed in this sheath composed only of adventitia and a small portion of the media is likely to perforate it at some point, not necessarily in immediate relationship to the intimal tear. If the perforation is close to the heart, rupture will be into the pericardium; if more distal, into either pleural cavity or occasionally into the retroperitoneal tissues and then into the abdomen. This external perforation is often difficult to demonstrate when it is not within the pericardium because of the blood clot in the loose surrounding tissues. Very rarely the blood may reenter the original lumen and thus produce a double-barreled tube; these are the cases that occasionally organize and heal (see Case 15, Table II). At autopsy the aneurysmal sacs occasionally

are found to be filled with blood clots of ante-mortem or post-mortem origin; very often the thin dissected channel has emptied following the last heartbeat.

The microscopic pathological changes are so intimately associated with the pathogenesis that they will be discussed together.

Originally the explanation that seemed most obvious, and actually the one that was first expounded by Virchow, was that most dissecting aneurysms arise on the basis of atheromatous ulcers. However, the fact that many of these cases occur in fairly young individuals without significant arteriosclerosis and that the majority of them begin in the ascending portion, where arteriosclerosis is minimal, has recently led to almost complete elimination of arteriosclerosis as an etiological factor. In our series, however, there is definite evidence that in four cases the primary intimal tear was on the basis of an arteriosclerotic ulcer, but in none of these did it occur in the ascending portion. In these four cases, moreover, the dissection was very short (except in one where it extended for 9 cm.), and the aneurysms did not penetrate the adventitia, reenter the original lumen, produce symptoms, or cause death. From this small group, therefore, one might infer that although arteriosclerosis is one cause of dissecting aortic aneurysms, it is responsible for only a small percentage of them (in Shennan's series, 6 out of 218 cases) and that, when it is the primary cause, the resultant aneurysm is usually small and asymptomatic and is not a factor in the patient's death. However, Shennan's cases show that this is not invariably the course in such cases.

Another theory, and one which is seldom mentioned in the literature, is that inflammation, that is, aortitis, is responsible. Theoretically there is no reason why an acute or chronic inflammation of the media should not weaken the wall sufficiently to predispose it to rupture. In two of our acute cases (Cases 4 and 10, Table I) there was a fairly diffuse infiltration of the media and adventitia with polymorphonuclear leucocytes and lymphocytes (Fig. 1). In both cases the Wassermann tests were negative, and the cells were not selectively distributed around the vasa vasorum, so that syphilis can fairly well be ruled out. The appearance slightly suggested a rheumatic aortitis, but in neither case was there any evidence, either clinically or pathologically, of rheumatic fever. Whether this degree of inflammation was a factor in the production of the aneurysm in these cases is still problematical. Can periarteritis produce enough damage to the vasa vasorum to diminish the medial blood supply and thus weaken the wall? Against this idea is the fact that syphilitic aortitis is almost never found as a background in cases of dissecting aneurysm. Tyson[21] has shown that the vasa vasorum may be obliterated either by arteriosclerosis or by a low grade inflammatory process with resultant medial hematoma and dissection without intimal tear. His findings are very suggestive that affections of the vasa vasorum may play an important rôle.

Closely allied with this last mentioned idea is what is now accepted as the most common etiological factor, namely, medial degeneration, or what has been termed by Erdheim[22] "medionecrosis aortae idiopathica cystica." The lesion was present in varying degrees in eight of our cases, six of which were in the acute group. This condition has been described so adequately by Erdheim, and recently in this country by Moritz,[23] that only a brief statement need be made here. The lesion consists of focal, and occasionally fairly diffuse, mucoid or hyaline degenerations of the media which result in cyst formation or what has often been called "faults." (Figs. 2, 3, and 4.) The whole sequence of these lesions can very easily be seen if numerous sections are taken. The etiology of these degenerations is still unsettled. Moritz was able to find them in 10 per cent of seventy adult aortas, but not in such a

Fig. 1.—Case 10. A microscopic section of an involved area showing dissection through the media. Note the subintimal atheromatous deposit, the emptied dissected channel, and the cellular infiltration of the adventitia. (×25.)

marked degree as those found in his three cases of dissecting aneurysm. He believes that it is associated with senility. Similar lesions, however, have been found in young individuals (for example, our Case 5, Table I), and have been produced experimentally in rabbits by the use of adrenalin. The consensus of opinion is that they are produced by various toxic agents associated with previous infections.

Granting the presence of some disease in the aorta—arteriosclerosis, infection, or degeneration—what is the immediate incitant that produces the aneurysm? Many observers have stressed overexertion, either physical or mental, especially associated with a hypertension. In our series of thirteen acute cases, five gave such a history: vomiting, sexual intercourse, trying a case at court, and in two cases, stooping to pick up a heavy object.

The frequent location of the initial tear in the ascending aorta about 1.5 cm. from the valve has suggested another theory for its cause, namely, the effect of the repeated diastolic recoil. This idea was first suggested by Löffler and is quoted by Shennan as follows: "When the aortic valves have closed, the abrupt recoil of diastole must bring about

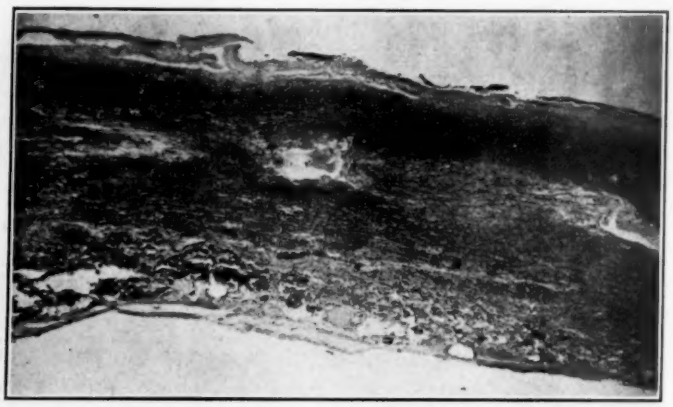

Fig. 2.—Case 9. A microscopic section of the aorta showing medial cystic necrosis. (×25.)

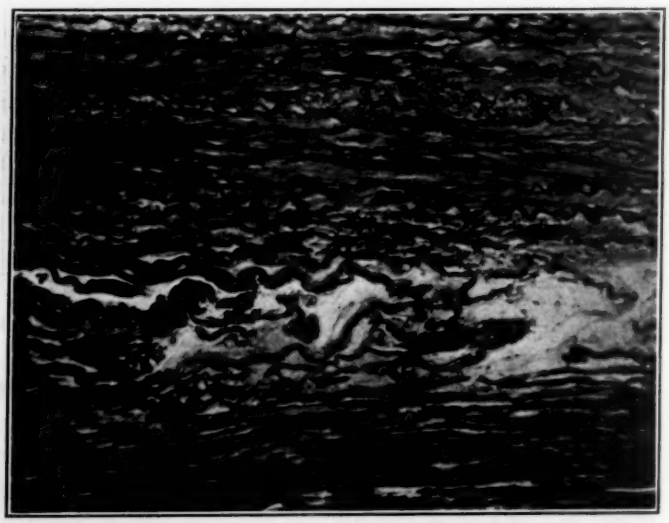

Fig. 3.—Case 9. A higher power view of Fig. 2 taken at the extreme left of the section, stained to demonstrate the elastica, showing degeneration of the elastic and muscle fibers. (×160.)

a longitudinal stretching of the ascending aorta, and must forcibly drive the aortic valve, along with the origin of the aorta, downwards and away from the transverse part." Somewhat against this idea is the fact that during diastole the base of the heart rises, releasing the tension on the ascending aorta. In our series of thirteen acute cases the tear

occurred in six in the ascending portion close to the valve. The perforation of the adventitia frequently occurred also in the ascending portion and very often at the same level as that of the original intimal tear. In our six cases, two aneurysms did not perforate at all, but the other four all perforated close to the initial tear.

According to Shennan, the reentrance of blood from the distal end of the dissected sac into the lumen of the vessel permits circulation through the new channel and is the most important determining factor in the process which leads to healing and the production of a separate channel. This is assisted by the circumstance that the new channel passes through tissues well supplied, at least on the outer aspect, with blood vessels from which organization can take place. Just how rapidly a new lining will form in the new channel is uncertain. However, the

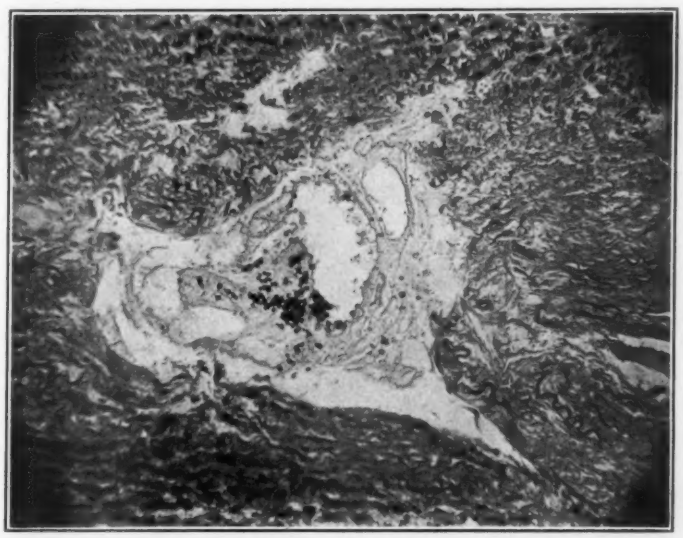

Fig. 4.—Case 9. One of the cysts. (×160.)

probable sequence of events is as follows. At first, a thin layer of thrombus is deposited on the damaged surfaces which then organizes to fibrous connective tissue. Extension of endothelium into the new channel from the mouths of ruptured aortic branches has been described by Shennan and others. It has also been suggested that the endothelial lining may develop in part at least from the new fibrous connective tissue lining the sac.

DIAGNOSIS

The clinical recognition of dissecting aneurysm of the aorta is dependent on the following points, several of which must be present before the diagnosis is justified: (1) The sudden onset, with pain reaching its maximum intensity at once or very quickly; (2) tearing or crushing pain located more often in the thorax, front or back, less often in the

abdomen; (3) wide radiation of pain, as a rule, from front of chest to back, or vice versa, often *downward* into the lower abdomen or legs, but almost never into the arms; (4) long-standing pain, hours to days, which responds poorly to the usual pain-relieving measures; (5) a history of considerable long-standing hypertension in most cases; (6) moderate to severe prostration, with or without loss of consciousness, even in the presence of extreme hypertension, which is often maintained for a varying length of time after the onset; (7) slight to moderate fever and leucocytosis for several days at least; (8) physical findings which may reveal little other than an extremely ill patient with a rapid, enlarged heart and hypertension or, in addition, evidence of blocking of the circulation to some part of the body, mainly the legs or head, as if by arterial embolism; (9) in some cases anuria, indicating dissection of the renal vessels; (10) electrocardiographic findings which are not characteristic of coronary thrombosis; (11) and, except in rare instances, sudden death a few hours to a few days after the onset of the illness as a result of rupture of the aneurysm externally into pericardium, pleura, mediastinum, or elsewhere.

DIFFERENTIAL DIAGNOSIS

The diagnosis was correctly made in only two of our thirteen acute cases. In the remaining eleven it was not even suspected. The following are the principal diagnoses considered in our series; pneumonia (2), angina pectoris (before coronary thrombosis was being diagnosed), coronary thrombosis, arteriosclerotic heart disease, hypertensive heart disease with acute congestive failure (cardiac asthma), chronic nephritis with uremia, embolism of iliac arteries, pulmonary embolism, pericarditis, and generalized peritonitis.

Coronary thrombosis is the condition with which dissecting aneurysm of the aorta is most often confused because of the thoracic location of the prolonged severe pain, which is attended by prostration and followed by slight fever and considerable leucocytosis in a middle-aged or elderly man. The following points are helpful in the differentiation: (a) the history of angina pectoris in most of the cases of coronary thrombosis and rarely in those of dissecting aneurysm; (b) the immediately overwhelming pain in the cases of dissecting aneurysm in contrast to the more gradually developing pain of coronary occlusion; (c) the widespread location and radiation of the pain of dissecting aortic aneurysm, often in or to the back, head, or abdomen, and to the legs, but rarely to the arms, which last mentioned radiation is commonly encountered in coronary thrombosis; (d) the frequent persistence of the hypertension in the case of dissecting aneurysm; (e) the evidence of very early obstruction of the arterial circulation to some part of the

body other than the heart in cases of dissecting aneurysm; and (f) the pathognomonic evidence, most important of all, of coronary thrombosis shown by daily electrocardiograms. It is of much interest that, whereas three out of every four patients with coronary thrombosis survive the acute attack, only one out of every four persons with dissecting aortic aneurysm survives.

Embolism of some part of the body, especially of the iliac, cerebral, or pulmonary arteries, is another condition likely to be confused with dissecting aortic aneurysm. The very severe pain in thorax or abdomen, without much breathlessness, the suddenness of the onset of trouble without previous evidence of disease of heart or veins which might provide a source for embolism, and the commonly fatal course of the illness serve to distinguish dissecting aneurysm in most cases. Conversely, a recent case,[24] incorrectly diagnosed as dissecting aortic aneurysm, at autopsy proved to be one of paradoxical embolism with occlusion of vessels to the left side of the head and left arm.

A surgical abdominal emergency, so called, is a diagnosis suggested by dissecting aneurysm, when it involves the abdominal aorta in particular. The suddenness of the severe pain which is likely to radiate downward on both sides, the old history of hypertension, and the absence of any previous trouble with the abdominal viscera or kidneys should at least arouse a suspicion of the correct diagnosis of dissecting aneurysm.

Pneumonia was diagnosed incorrectly in two of our cases, but the differentiation should generally be easy, because of (a) the suddenness of the onset with very severe pain, (b) the absence of evidence of pulmonary consolidation, and (c) the low fever and slight or absent cough, when dissection of the aortic wall takes place.

It should be noted finally that death in a number of cases of dissecting aneurysm has come rapidly either from vasomotor shock or from aortic rupture, so that dissecting aortic aneurysm must be added to the causes of fairly sudden death. Conversely, slight tears and small dissections may apparently take place with little or no clinical evidence, such lesions, acute or healed, being incidental necropsy findings in patients who have died of other causes.

PROGNOSIS

Dissecting aortic aneurysm of the "acute clinical type" is an overwhelming illness ending suddenly in death within a few hours or days Among the cases with rather extensive aortic dissection in this series, only one in fourteen recovered completely (Case 15, Table II). Occasionally the dissecting aneurysm may not rupture externally for several weeks or months, permitting a longer survival. Rarely, when spontaneous rupture back into the lumen of the aorta or one of its large

branches occurs, there is recovery with survival for months or years. Such a case is included in this report in which no antecedent clinical event pointed to the existence of an old, healed "double-barreled" aorta.

Clinically, as a rule, the patients are extremely ill and run a steady downhill course. Loss of consciousness is not uncommon. The few patients who survive the initial attack and show some improvement later die suddenly without warning sign or symptom. The exceptional case that comes to post-mortem examination showing an extensive healed dissecting aneurysm, obviously not the cause of death, has not to our knowledge been observed or diagnosed correctly during life. Undoubtedly, small dissections occur without producing significant signs of symptoms.

TREATMENT

The only rational medical treatment of dissecting aneurysms of the aorta consists of keeping the patient absolutely quiet under opiates and sparing him every effort that might further increase the strain on the outer wall of the dissected portion of the vessel.

A recent case reported by Gurin and his associates[14] opens up the possibility of surgical intervention in certain cases in which the dissection has extended into the large vessels of the pelvis. In Gurin's case, the aortic dissection had advanced into the right external iliac artery involving one-third of the circumference of the vessel on its lateral aspect and opposing the intimal surfaces so as to cause nearly complete obstruction to the flow of blood to the lower extremity. An undissected area of the vessel was incised, and when the lumen was found so reduced by pressure from blood within the coats of the vessel, the intima was also incised, allowing the flow of blood from the dissected cavity back into the lumen of the vessel, thus relieving the increased pressure from above within the vessel wall and restoring the circulation to the extremity, which was maintained until death six days later. This is, in effect, precisely what occurs spontaneously at times, thus preventing external rupture which is so invariably fatal. The occasion to attempt such a measure surgically will be rare and will occur in the experience of only a few of us. But, when dealing with such a highly fatal condition, it is well to remember that such a possibility exists.

SUMMARY AND CONCLUSIONS

A clinical and anatomical analysis has been made of thirteen cases of dissecting aortic aneurysm directly related to the death of the patient, and of six other cases found incidentally among 8,200 necropsies of patients of all ages at the Massachusetts General Hospital. Included also is the report of a case in which dissection occurred between the coats of the wall of a coronary vessel. Among the thirteen "acute"

cases the diagnosis was made correctly during life in two, bringing the total of correct ante-mortem diagnoses recorded in the literature to thirteen or more.

Dissecting aortic aneurysm occurs predominantly in males between forty and sixty years of age in whom there is an antecedent history of hypertension. Whereas the clinical picture does not conform strictly to a pattern, there are certain features that, when combined, should point to the correct diagnosis. Among these are (1) sudden onset of severe tearing or crushing pain, usually thoracic, reaching its maximum intensity at once, in a person with a history of hypertension; (2) wide but variable radiation of the pain to the head, back, abdomen, or lower extremities, or to all of these, but rarely to the arms; (3) moderate to extreme collapse, and occasionally unconsciousness, even though the blood pressure may be maintained for some time at a high level; (4) evidence of arterial obstruction to the head, extremities, or kidneys when dissection along the branches of the aorta has occurred; (5) a rapid, enlarged heart, with or without significant murmurs; (6) slight to moderate fever and leucocytosis; (7) occasionally hoarseness, when rupture has occurred into the mediastinum; and (8) a variety of signs and symptoms which must be interpreted in the light of other evidence in each individual case. Coronary thrombosis and peripheral arterial embolism, particularly of the iliac, cerebral, or pulmonary vessels, are the two conditions most likely to be confused with dissecting aortic aneurysm.

Survival after the onset of symptoms, among the acute cases, averaged approximately four days, with three exceptions in whom the duration of life was six, eight, and fifteen weeks respectively. Among the incidental cases there was one patient who showed, at autopsy, a "double-barreled" aorta, which condition was unrelated to his death.

Pathologically, the predominant features are (1) intimal rupture near the aortic valve ring, (2) dissection of the medial coat of the aorta, and (3) some degree of medial degeneration. Medionecrosis aortae idiopathica cystica (Erdheim) was present in nearly one-half (six) of our acute cases and in two of our six incidental cases. Syphilis was not found as an etiological factor in any case. Proximal dissection involving the mouths of the coronary vessels occurs at times and may cause confusion in differentiating dissecting aneurysm and coronary thrombosis.

Clinical interest in this dramatic condition is mounting as shown by the increasing number of reports of correctly diagnosed cases in recent years. In paying particular attention to the clinical aspects of the disease, it is our hope that further reports of this nature will be forthcoming to add to our increasing knowledge and diagnostic acumen.

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ELECTROCARDIOGRAPHIC CHANGES IN NORMAL ADULTS FOLLOWING DIGITALIS ADMINISTRATION*

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THERE are available in the literature only comparatively few observations on changes in the electrocardiogram following digitalis administration, and the results reported are not in complete agreement. We have therefore carried out a series of investigations on this problem, observing in a group of healthy individuals the effect of administration of a therapeutic dose of a well-defined constant digitalis preparation.

In this paper an account will be given of the effect of digitalis on each of the different parts of the electrocardiogram, and the conclusions of previous investigators will be considered in relation to the report on our own observations.

METHOD

The study includes observations on 15 individuals (14 men and 1 woman) between the ages of nineteen and thirty-one years. None of the subjects had previously presented any cardiac symptoms, and a thorough clinical examination, including auscultation of the heart, reading of blood pressure, electrocardiography and roentgenography, had failed to reveal anything abnormal.

The digitalis preparation used was "Tabl. folii digitalis (Pharmacopea danica 1933)." This preparation is made of leaves from digitalis purpurea. The leaves are purchased in large quantities, and standardized by the eventual addition of extracted leaves, so as to obtain a constant strength, deviating by less than 5 per cent from 2,000 frog units per gram (tested on specially selected frogs).

To each one of the first ten subjects examined, 1 gm. of this preparation was given as a single dose. To subjects Nos. 11 and 12, 1.4 gm. was given, 0.6 gm. as an initial dose, followed after twenty-four hours by a dose of 0.8 gm. The remaining three subjects (Nos. 13 to 15) received a total of 3 gm. during a period of two weeks (0.8, 0.6, 0.4 and 0.2 gm. during the first four days, followed by 0.10 gm. daily for ten days).

The electrocardiograms were obtained under as constant conditions as possible, always in the morning (with the exceptions given below), the individuals fasting, and after at least a half an hour's complete relaxation in the electrocardiography room. The usual leads were taken from the extremities of the reclining person. Electrocardiography was performed three to five times previous to the digitalis administration, and 1, 2, 4, 8 and 24 hours and 2, 3, 4, 7 days and so on afterward with decreasing frequency, if possible until the disappearance of the electrocardiographic changes.

The electrocardiograms were obtained by means of an amplifier apparatus, which permitted the simultaneous registration of all three leads. Each electrocardiogram was standardized for a test potential of 1 mv. for determination of the millivoltage of the waves (1 mv. = 19 – 22 mm.). The height of the waves was measured with

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a pair of compasses and a diagonal ruler; the measurements were always performed on five to seven consecutive complexes in each electrocardiogram, and the height of the waves calculated as the mean value, expressed as millivolts.

The time indication represented 0.05 sec. As the velocity of the film was 7 to 8 cm. per second, the length of the various intervals could be measured with an accuracy of 0.005 sec. Also for these determinations the mean value of 5 to 7 consecutive complexes was calculated. The length of the intervals was estimated in Lead II only.

CHANGES OF THE P-WAVE

Cohn and Fraser[4] in all their subjects studied observed changes of the P-wave, but no report is available concerning the nature of these changes. Routier and Puddu[16] found changes of the P-wave in four out of twelve healthy subjects, the wave becoming lower, diphasic, or negative; these changes usually occurred in Leads II and III. In contrast to these findings White and Sattler[20] observed no changes of the P-wave in ten healthy young men.

In the present studies no definite changes in the height or shape of the P-wave were seen.

CHANGES OF THE LENGTH OF THE P-Q INTERVAL

Whereas Stewart and Cohn[18] found no increase in the length of the P-Q interval in six normal individuals following ingestion of a single dose of 0.8 to 1 gm. of digitan, such increase was observed by most other investigators in at least some of the subjects studied. Thus Cohn and Fraser[4] found prolonged P-Q interval in each of four normal individuals after doses corresponding to 2 to 4 gm. of digitalis leaves. White and Sattler[20] observed increases of 0.01-0.02 sec. in the P-Q interval in seven out of ten healthy young men following ingestion of 2 to 3 gm. of digitalis leaves during a period of seven to eleven days. Dieuaide, Tung, and Bien[7] found the P-Q interval prolonged by 0.01-0.04 sec. in four normal subjects after doses of digitalis corresponding to 1 to 1.2 gm. of digitalis leaves. Finally van Dyke and Li[8] observed in four normal individuals increases of 0.005-0.015 sec. following digitalis administration in doses, which are not reported in their paper. In all instances the duration of P-Q was below 0.20 sec. McCulloch and Rupe,[6] after digitalis administration to thirty-six children presenting no evidence of heart disease, following a schedule of dosage outlined in their paper, observed in 9 cases a characteristic change in the length of the P-Q interval, the length varying with the diastole, being shorter after a long diastole and longer after a short diastole. This abnormality was classified as "sinus arrhythmia," and it was expressly stated that the duration of the R-R and P-Q intervals was independent of the respiratory phase. In three other children prolonged P-Q interval was likewise found, but not varying with the length of the diastole. Brams and Gaberman[2] once observed prolonged conduction time (P-Q = 0.34

sec.), and once a 2-to-1 block. Finally it should be mentioned that McCulloch and Rupe,[6] Georgopoulus,[10] Samet and Tezner[17] each observed one case of sino-auricular block following the administration of digitalis to normal individuals.

In four out of fifteen subjects examined during the present study, definite prolongation of the P-Q interval was found, e.g., increases above 0.01 sec. (Table I). In two individuals (Nos. 1 and 8) the prolongation was only moderate (0.015 and 0.011 sec., respectively), and the duration of the P-Q interval did not exceed 0.20 sec. Each of the two other subjects (Nos. 2 and 13) had a slow pulse rate previous to the digitalis administration (50.5 and 42.5 beats per minute) and P-Q intervals of a duration of 0.205 and 0.197 sec., respectively, and low P-waves. In both these individuals the digitalis ingestion caused changes quite similar to those classified by McCulloch and Rupe as "sinus arrhythmia." In subject No. 13, a marked respiratory arrhythmia was noticed on the second day following the digitalis administration (Table II), with varying duration of P-Q, the interval being short (0.215 sec.) after a long diastole, and long (0.28 sec.) after a short diastole. If the person was made to stop breathing, the P-Q interval became of the same length (0.27 sec.) with each heartbeat. In subject No. 13 similar observations were made on the eleventh and twelfth days of the experiment, e.g., after ingestion of 2.7 to 2.8 gm. of digitalis. In this individual deep and slow breathing caused no respiratory arrhythmia, but the duration of P-Q varied with the respiratory phase from 0.16 to 0.23 sec. This variation disappeared when the subject was made to stop breathing; under these conditions a marked shortening of the P-Q interval was noticed (0.12 to 0.14 sec.), the duration of the interval being shorter than at any other time during the whole experimental period (Table II). In subject No. 15 a varying length of the P-Q interval was observed both before and after the digitalis administration; this individual had a definite respiratory arrhythmia and a very low P_1; the pulse rate was 51 to 68.

CHANGES OF THE QRS COMPLEX

According to Georgopoulus, the height of the initial complexes increases in normal individuals after digitalis administration.

In the present investigations no notable changes of the QRS complex were observed. In three individuals the R_1-wave from the second to the fifth day following the digitalis ingestion was 0.15-0.25 mv. (3-5 mm.) lower than before the administration and long time afterward. In two of these three subjects the R_3-wave at the same time was a little higher. In subject No. 13, who had received 3 gm. of digitalis, the R_1- and R_2-waves, twenty-five days after the digitalis ingestion, still were definitely lower than before the administration; at this time the observations were

TABLE I

MAIN ELECTROCARDIOGRAPHIC CHANGES FOLLOWING DIGITALIS ADMINISTRATION TO FIFTEEN NORMAL ADULTS

INDIVIDUAL NO.	BEFORE OR AFTER DIGITALIS ADMINISTRATION	P-Q (SEC.)	S_1-T_1	S_2-T_2	T_1 (MV.)	T_2 (MV.)	T_3 (MV.)		LENGTH OF Q-T INTERVAL PER CENT*	HEART RATE
1	Before	0.120	positive	positive	0.48	0.38	+0.40		100.6	60
	After	0.135	lower	lower	0.30	0.24	+0.32		96.0	46
2	Before	0.205	isoelectric	isoelectric	0.10	0.28	0.26		101.0	51
	After	0.275	negative	negative	0.02					
					+0.01	0.09	0.13		87.0	50
3	Before	0.170	positive	positive	0.20	0.35	0.21		100.0	59
	After	0.175	isoelectric	isoelectric	0.07	0.18	0.10		88.0	48
4	Before	0.167	positive	positive	0.29	0.44	0.22		103.5	52
	After	0.173	lower	lower	0.21	0.22	0.09		94.5	53
5	Before	0.171	positive	positive	0.35	0.54	0.30		100.5	43
	After	0.171	lower	lower	0.25	0.39	+0.06	+0.08	89.5	42
6	Before	0.155	positive	positive	0.18	0.40	0.28		97.5	59
	After	0.164	unchanged	unchanged	0.19	0.38	0.20		92.5	52
7	Before	0.149	isoelectric	positive	0.15	0.21	0.20		102.5	62
	After	0.151	unchanged	isoelectric	0.09	0.15	+0.12	+0.05	94.5	51
8	Before	0.147	positive	positive	0.38	0.68	0.42		93.0	67
	After	0.158	unchanged	lower	0.31	0.41	0.15		84.5	56
9	Before	0.158	positive	positive	0.15	0.31	0.20		104.5	57
	After	0.165	unchanged	lower	0.12	0.15	+0.05	+0.05	98.0	52
10	Before	0.140	positive	isoelectric	0.33	0.34	+0.10	+0.15	101.5	58
	After	0.146	lower	negative	0.18	0.19	+0.22	+0.08	94.5	56
11	Before	0.140	positive	positive	0.37	0.40	+0.05	+0.05	97.0	51
	After	0.138	lower	lower	0.20	0.23	+0.10	+0.10	90.5	48
12	Before	0.169	positive	positive	0.21	0.36	0.25		100.0	62
	After	0.173	lower	isoelectric	0.08	0.10	+0.19		91.5	51
13	Before	0.197	positive	positive	0.42	0.60	0.30		103.5	43
	After	0.230	lower	isoelectric	0.24	0.33	0.14		93.5	33
14	Before	0.180	positive	positive	0.38	0.58	0.33		101.5	60
	After	0.182	lower	lower	0.27	0.40	0.12		89.0	60
15	Before	0.14-0.17	positive	positive	0.18	0.52	0.35		104.5	68
	After	0.14-0.17	lower	lower	0.15	0.23	0.12		91.0	52

*The percentage values are calculated for the respective heart rates from the equation given by Fridericia.

discontinued because of external causes. On the other hand, no changes in the height of the initial complexes were seen in subjects Nos. 14 and 15, who had likewise received 3 gm. of digitalis.

CHANGES OF THE S-T INTERVAL

Changes of the S-T interval appear to have been only rarely the subject of special consideration in the literature. Pardee[15] observed depression of the S-T interval in eight individuals presenting no evidence

TABLE II

The Length of the R-R_2, P-Q_2, and Q-T_2 Intervals in 14 Successive Heartbeats, in Two Individuals Presenting Prolonged Conduction Time Due to Digitalization, Under Normal Breathing and During Cessation of Respiration

INDIVIDUAL NO. 2				INDIVIDUAL NO. 13			
BEAT NO.	PRECEDING R-R_2 INTERVAL (SEC.)	P-Q_2 (SEC.)	Q-T_2 (SEC.)	BEAT NO.	PRECEDING R-R_2 INTERVAL (SEC.)	P-Q_2 (SEC.)	Q-T_2 (SEC.)
			Normal Respiration				
1	1.17	0.22	0.36	1	–	0.21	0.44
2	0.88	0.25	0.35	2	1.74	0.23	0.43
3	0.96	0.28	0.355	3	1.78	0.17	0.45
4	1.405	0.215	0.36	4	1.78	0.16	0.45
5	1.235	0.215	0.36	5	1.77	0.18	0.44
6	0.88	0.25	0.36	6	1.76	0.20	0.45
7	0.925	0.28	–	7	1.76	0.23	0.45
8	1.40	0.215	0.36	8	1.75	0.22	0.44
			Cessation of Respiration				
9	1.105	0.24	0.36	9	1.79	0.16	0.45
10	0.94	0.27	0.355	10	1.83	0.15	0.45
11	1.075	0.27	0.355	11	1.82	0.13	0.45
12	1.105	0.26	0.36	12	1.78	0.14	0.44
13	1.015	0.27	0.35	13	1.76	0.14	0.46
14	0.96	0.27	0.35	14	1.75	0.12	0.45

of heart disease, and Routier and Puddu[16] observed changes in eight out of twelve normal persons; the nature of these changes is, however, not specified.

In the present study the changes in the S-T interval were found to be closely connected with changes in the height of the T-wave. As will be seen from Table I, the S-T_1 and S-T_2 lines in most of the cases examined were a little above the isoelectric line before the digitalis administration and after the ingestion usually approached or reached this line. Only in two instances did the S-T line descend below the isoelectric line, in one of the cases in both Lead I and Lead II, in the other case in Lead II only; in both the cases the S-T line was isoelectric before the digitalis ingestion. In those instances where no change was observed in the S-T interval no changes were seen either in the corresponding T-waves. This occurred four times in Lead I and once in Lead II.

CHANGES OF THE T-WAVE

Although the statements in the literature concerning the effect of digitalis administration on the shape of the T-wave in normal subjects on the whole are in good agreement, all possible variations have been reported. Thus Nicolai and Simons[14] found T_1 lower in one and higher in four normal individuals after administration of 1.5 gm. of digitalis during a period of five days. Samet and Tezner[17] in their observations on children occasionally found the T-wave unchanged or higher, although there were clinical symptoms of intoxication present. Some of the children were stated to be in good health, whereas others had just recovered from pneumonia. Brams and Gaberman[2] gave digifolin intravenously to nine healthy individuals until the appearance of symptoms of intoxication. In four cases the T-waves remained unchanged, in five cases the waves became 1 to 3 mm. lower, but these moderate changes were interpreted by the authors as being due to extracardial conditions, for instance, changes of position. Several investigators observed flattening of the T-waves in most of the persons examined (White and Sattler,[20] Kahlson,[12] Grünbaum[11]). Others have noticed even greater changes. Both Cohn[5] and Pardee[15] found inversion of the T-waves in normal individuals following digitalis administration, but their publications contain no information concerning the number of cases in which this change was observed, nor is it reported whether the individuals showed any signs of intoxication. The dose of digitalis used by Cohn was 2 to 3 gm. of digitalis leaves, given in the course of five to seven days, whereas Pardee gave 1 minim by mouth of digitalis tincture per pound of body weight (1.25 c.c. = 1 cat unit). Marvin, Pastor, and Carmichael[13] gave preoperatively to thirty patients during two to three days a total of 1.5 gm. of digitalis leaves per 45 kilograms of body weight, and in twenty-nine of these cases observed "a characteristic inversion of the T-wave or of the S-T interval"; only five of the thirty patients suffered from unquestionable heart diseases. Routier and Puddu[16] found inversion of the T-wave in six out of twelve normal subjects following the daily intravenous administration of 0.0002 gm. digitaline cristallisée for five or ten days. Finally Stewart and Cohn,[18] Grünbaum,[11] Cheer and Dieuaide[3] each observed one case of inversion of the T-waves. In some of these cases the subjects had been digitalized until the occurrence of symptoms of intoxication.

In the present investigations changes in the shape of the T-waves were found in fourteen of the fifteen individuals studied (Table I).

In Lead I the T-wave was found unchanged in six cases and lower in nine cases, in one of these diphasic.

In Lead II the T-wave was found unchanged in two cases and lower in thirteen cases.

In Lead III the T-wave was found unchanged in three cases; in seven cases a positive T_3 became lower, but remained positive; in three cases a positive T_3 became diphasic, and in one case negative. Finally in one case an original diphasic T_3 became practically negative during the influence of the digitalis.

It should be mentioned that the T-waves have been classified as lower only in those cases in which on measurement a reduction of at least 0.1 mv. was found as compared with the average height before the digitalis administration; in the electrocardiograms taken before the ingestion, the variations in the height of the T-waves were always less than 0.1 mv. The T-waves were found reduced to 33 to 67 per cent of their original height, or a reduction of 0.1 to 0.25 mv., corresponding to a 2 to 5 mm. reduction in the electrocardiogram, a change which is easily perceptible with the naked eye.

CHANGES IN THE LENGTH OF THE Q-T INTERVAL

In later years several Chinese investigators (Cheer and Dieuaide,[3] Dieuaide, Tung and Bien,[7] van Dyke and Li,[8]) have studied the length of the Q-T interval under various conditions. They have employed the equation of Bazett,[1] according to which $Q\text{-}T = K\sqrt{R\text{-}R}$. Changes in the length of the Q-T interval which are caused by changes in the pulse rate will be expressed as variations of the constant K. After administration of digitalis to thirteen normal individuals, these investigators in all instances observed a shortening of the Q-T interval.

In the present investigations a relative shortening of the Q-T interval was found in all the cases studied (Table I).

According to Fridericia[9] there exists in normal individuals the following relationship between the length of the Q-T interval and the pulse rate: $Q\text{-}T = 8.22\sqrt[3]{R\text{-}R}$. Our measurements show a very good agreement with this equation, the length of the Q-T interval in fourteen of the individuals before the digitalis administration being 97-104.5 per cent of the value calculated from the equation, whereas in subject No. 8 an interval was found equaling 93 per cent of the calculated value. While the digitalis influence was at its maximum the Q-T interval was reduced to only 87-98 per cent of the calculated value, all the individuals, as seen from Table I, presenting a relative shortening amounting to 4.6 to 14 per cent. This shortening bore no relation to the degree of flattening of the T-waves.

It will be noticed that only three of the individuals studied presented a shortening of or exceeding 0.045 sec. in relation to the value calculated from the equation. According to Fridericia, the deviation must exceed 0.045 sec. to be classified as abnormal. However, the observed digitalis effect appears unquestionable as it was found in all the individuals in a series of electrocardiograms taken shortly after the digitalis adminis-

tration, whereas the changes were not present in the electrocardiograms obtained before, or a long time after, the administration. The observance by White and Mudd[19] of a similar strictness in the requirements as those laid down by Fridericia explains the statement of these authors of having observed no shortening of the Q-T interval after administration to normal individuals of 2 to 3 gm. of digitalis leaves, a dose which caused moderate symptoms of intoxication. By looking over their figures it will be seen, however, that a relative shortening of the Q-T interval took place in four of the five individuals studied, the reduction ranging from 3 to 6.5 per cent.

CHANGES OF THE HEART RATE

According to Pardee,[15] changes in the pulse rate are observed less frequently than changes in the shape of the T-waves. Nevertheless, several investigators, including Stewart and Cohn,[18] Brams and Gaberman,[2] Routier and Puddu,[16] claim to have observed a slower pulse rate in nearly all the individuals studied. On the other hand White and Sattler[20] noticed a slower pulse in only four out of ten healthy young men, and McCulloch and Rupe[6] found a reduction of the pulse rate amounting to 15 beats or more per minute in only nine of thirty-six children who presented no evidence of heart disease.

In the present investigations the heart rate was found to decrease by 5 beats or more per minute in nine out of fifteen subjects studied. In six of the nine cases the reduction valued 10 beats or more per minute, the decreases being calculated as the differences between the minimum values before and after digitalis administration.

CHANGES OF RHYTHM

The occurrence of arrhythmia in normal individuals following digitalis administration appears to be infrequent. The occurrence of 2-to-1 block in the case observed by Brams and Gaberman[2] was followed by transitory auricular fibrillation. A case of paroxysmal auricular fibrillation in a child is reported by Samet and Tezner.[17]

As mentioned above, one of the subjects studied during the present investigations had a marked respiratory arrhythmia following the digitalis administration. Other types of arrhythmia were not observed.

TIME OF APPEARANCE AND DURATION OF THE CHANGES

The duration of the electrocardiographic changes following digitalis administration appears to be of special interest. According to Cohn,[5] the T-waves had returned to normal from five to twenty-two days after the digitalis ingestion. In the cases observed by White and Sattler,[20] the changes lasted for ten to nineteen days. However, in most of Grünbaum's cases[11] the changes persisted for a few days only, although in one case with inversion of the T-waves they lasted for thirty days.

According to Cheer and Dieuaide,[3] the shortening of the Q-T interval appears simultaneously with the flattening of the T-waves but again disappears before the T-waves regain their initial height.

Of the ten subjects who received 1 gm. of digitalis as a single dose three persons presented changes of the Q-T interval within two hours after the digitalis administration; in four the changes appeared after four hours, in two cases, after eight hours, and in one case, not until twenty-four hours after the ingestion. The maximum change was observed from twenty-four to seventy-two hours after the digitalis administration; the length of the Q-T interval was returned to normal after five to twenty-nine days.

In the two individuals receiving 1.4 gm. of digitalis in fractional doses, the change in the length of the Q-T interval appeared twenty-four and thirty-three hours after the first administration and was at its maximum from the second to the sixth day. The length of the Q-T interval was returned to normal twenty-two and ten days after the digitalis ingestion had been discontinued.

In the three individuals receiving 3 gm. of digitalis the first electrocardiogram after the digitalis administration was obtained twenty-four hours after the first dose had been given. At this time the Q-T interval was found shortened in all the three cases. The maximum shortening was observed four days after the first ingestion and persisted during the whole period of digitalis administration. In No. 13 the Q-T interval was returned to its normal length twenty-five days after the last dose, and in No. 14 after thirty days, whereas in No. 15 the shortening was still present thirty days after the last administration, at which time the observation was discontinued due to external conditions.

The flattening of the T-waves was frequently found to occur simultaneously with the shortening of the Q-T interval, but might appear a little earlier or later. In some instances the height of the T-waves returned to normal slightly before the Q-T interval had regained its normal length, in other cases these changes took place simultaneously, and in still other cases the T-waves remained flattened after the Q-T interval had again become normal. In one individual, who had received 3 gm. of digitalis, a marked flattening of the T-waves still persisted twenty-five days after the digitalis administration, at which time the observations were discontinued. After the ingestion of 1 gm. of digitalis the flattening of the T-waves lasted for twenty-one days at the most.

Concerning the time of appearance of the other changes it can be stated that the changes in the S-T interval usually occurred simultaneously with the changes in the T-waves. Reduction of the pulse rate and changes in the length of the P-Q interval were observed simultaneously with the maximum reduction of the height of the T-waves; these changes persisted, however, for a shorter period than the flatten-

ing of the T-waves. In the two instances where an increase of the length of the P-Q interval was found, varying with the respiratory phase, this change persisted for only five and two days, respectively.

SYMPTOMS OF INTOXICATION

Four of the subjects studied presented slight symptoms of intoxication. Thus No. 3 and No. 15 claimed slight dyspnea on exertion eight to ten hours after intake of 1 and 1.4 gm. of digitalis, respectively. No. 6, ten hours after the ingestion of 1 gm. of digitalis, experienced slight nausea and dizziness. No. 13, after receiving approximately 2 gm. of digitalis through a period of five days, suffered slight nausea and palpitations during the successive four to five days; these symptoms occurred three to four hours after the ingestion of a daily dose of 0.1 gm. of digitalis and usually lasted for about half an hour. No special changes were observed in the electrocardiogram at the time of appearance of these symptoms.

DISCUSSION

In all the subjects studied a relative shortening of the Q-T interval was observed after digitalis administration. Only a few investigators have measured this interval, but they all have noticed this shortening; only in one of the five individuals studied by White and Mudd no reduction of the length of the Q-T interval was seen following digitalis administration. It must therefore be considered as established that digitalis produces a shortening of the systole as compared with the pulse period. This fact is in agreement with the demonstration by Wiggers and Stimson[21] of a shortening of the systole following strophanthin administration to vagotomized dogs, whose heart rate was kept constant through electric stimulation of the atrium.

In regard to the changes in the height of the T-waves, the results of some investigators are not in agreement with our observations. The finding by Nicolai and Simon[14] of higher T-waves in normal individuals following digitalis administration appears to be exceptional. However, consideration should be made of the fact that this publication dates from 1909, e.g., from the earliest days of electrocardiography, and that no information is given concerning the electrocardiographic technic, particularly the standardization of the electrocardiograms. It therefore appears possible that this exceptional finding may be explained by a deficient technic. Several investigators have observed more marked changes of the T-waves (inversion) than was found in the present study, although the doses of digitalis given were of the same size and the way of administration similar, large single doses being given. However, the clinical data for the individuals studied are scarce. In the group of subjects examined by Marvin, Pastor, and Carmichael[13] patients of all age groups, suffering from diseases necessitating major

operations, were included, most of the individuals, however, presenting no signs of heart disease. The other authors merely state that the subjects suffered from no diseases of the circulatory system, but no information is given concerning the age of the individuals. In contrast to this all the individuals studied in the present investigations were young and healthy.

The other changes in the electrocardiogram observed during the present studies were found in a few individuals only. Our observations therefore permit the conclusion that different individuals may behave differently toward the same dose of digitalis.

The electrocardiographic changes were found to persist up to a period of about one month, a fact which must be considered in interpretation of electrocardiograms from patients who have received digitalis.

SUMMARY

1. Electrocardiograms were obtained in fifteen young, healthy individuals following the administration of a therapeutic dose of digitalis.

2. In all the individuals studied, a relative shortening of the Q-T interval was found.

3. In fourteen of the fifteen individuals studied, the T-waves became lower in one or more leads, but in one case remained unchanged.

4. The heart rate became slower in nine of the fifteen cases.

5. In four cases the conduction time increased. In two of these cases the P-Q interval was above 0.20 sec.; in both these instances the length of the interval varied with the respiratory phase.

6. Electrocardiographic changes were noticed, at the earliest, two hours after the digitalis ingestion.

7. The electrocardiographic changes persisted for a period up to thirty days.

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AURICULAR FIBRILLATION WITH CONGESTIVE FAILURE AND NO OTHER EVIDENCE OF ORGANIC HEART DISEASE*

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IN RECENT years it has become generally recognized that auricular fibrillation may occur in an otherwise normal heart. Among the more important publications relating to this problem are those of Parkinson and Campbell,[1] Fowler and Baldridge,[2] Friedlander and Levine,[3] and Orgain, Wolff and White.[4] It is less commonly appreciated, however, that auricular fibrillation, apart from any other disease of the heart, may cause severe congestive failure and that upon cessation of the arrhythmia, the congestive failure may be followed by complete and lasting recovery. Such clinical occurrences are admittedly uncommon, yet their recognition is exceedingly important, since a prompt diagnosis and immediate application of appropriate therapy make possible a favorable prognosis in what might otherwise prove a serious and disabling illness.

In view of the above considerations the following report is presented.

REPORT OF A CASE

History.—A married woman, aged forty-three years, was first seen June 11, 1935. On June 1, 1935, she had consulted her family physician with the complaints of shortness of breath, weakness, and fatigue. Her father had died of angina pectoris at sixty-three years, her mother, of breast cancer at fifty-seven years, and her brother, aged forty-six years, was living and well. In childhood she had had mumps, measles, and chickenpox. She had also suffered frequent sore throats, which ceased after a tonsillectomy at the age of fourteen years. She had never had rheumatism or chorea, but during the past fifteen years she had had several attacks of "sinus trouble," and her antrums were punctured several times. Menstruation began at thirteen years and had always been normal.

She was married twenty-five years ago. Her husband, and two children aged twenty-three years and fifteen years, respectively, are living and well. There were no miscarriages. On several occasions during the past eight or ten years, she has consulted her family physician for the purpose of obtaining a diet to reduce her weight. This was for purely esthetic reasons. In fact, her weight was never excessive, usually fluctuating between 135 and 140 pounds. On one of these occasions her basal metabolic rate was determined and found to be -7 per cent. On the advice of her physician she did not diet severely, nor did she take thyroid extract or any other reducing drug. Her urine and blood pressure have been examined frequently, during her pregnancies and on various occasions since, and have always been found normal.

Her present illness is traced back to about the middle of January, 1935, when she suffered an attack of "sinus trouble," lasting two to three weeks. There was

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slight fever at the onset. During that illness she was under the care of an oto-laryngologist, who kept her at rest for two or three days and thereafter treated her at his office for about two weeks. Her antrums were washed several times during that period. In a comparatively short time she resumed her normal activities and considered herself fairly well, but she noticed that she tired more easily than she had in the past.

About the middle or the end of March, 1935, she began to experience some difficulty in going to sleep because of a peculiar uneasiness in her chest, of which she would become aware upon retiring. She often found it more comfortable sitting up in a chair than lying in bed. She attributed those symptoms to "just nervousness" and continued a rather active social life for another two months; but about the middle of May, 1935, she noticed that she was getting short of breath and that she was gaining weight. At first she gained about two pounds per week, but early in June, the gain in weight became very rapid, and on June 11, 1935, she weighed 160 pounds, showing an increase of 25 pounds in less than a month.

Examination.—On June 11, 1935, physical examination revealed evident dyspnea at rest, moderate ankle edema, and signs of fluid in the pleural, pericardial and peritoneal cavities. The heart rate at the apex was 160 per minute; the rhythm was

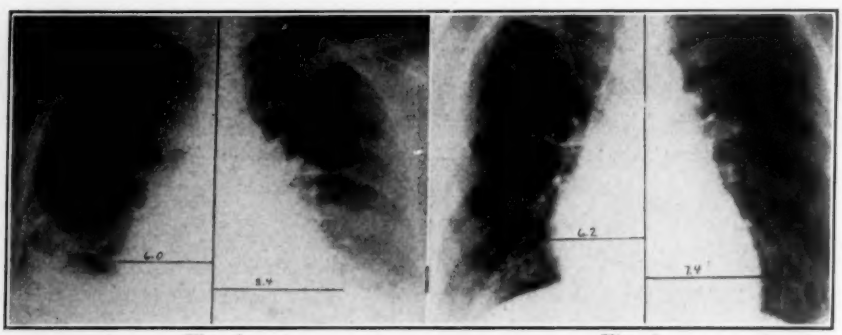

Fig. 1. Fig. 2.

Fig. 1.—Film taken June 8, 1935, showing passive congestion and fluid in pleural cavities. The transverse diameter of cardiac shadow measures 14.4 cm.

Fig. 2.—Film taken June 17, 1935, showing slight passive congestion. No sign of fluid in pleural cavities. The width of the cardiac shadow is now 13.6 cm.

grossly irregular, and there was a systolic apical murmur. An x-ray film of her chest (Fig. 1) taken on June 8, three days before this examination, reveals essentially the same condition, though not so far advanced as the changes found June 11, 1935.

Diagnosis.—The existence of auricular fibrillation with congestive failure was obvious; but the underlying anatomical and physiological pathology remained obscure, since no clue to their identity could be discovered either in the history or by physical examination.

The patient was at her home at the time of this examination, and, since she had already received small doses of digitalis during the preceding two or three days, it was thought best to complete the digitalization before removing her to the hospital for further observation. Adequate digitalization during the ensuing six days caused great diuresis, accompanied by a loss of 15 pounds in weight, and a reduction of the pulse rate to 85 per minute. The patient's condition improved greatly, and on June 17, 1935, she was removed to St. Vincent's Hospital. An x-ray film of her chest (Fig. 2) taken on that day confirmed the clinical evidence of the disappearance of the pleural and pericardial effusions and the marked reduction in passive

congestion. An electrocardiogram (Fig. 3) made the same day showed the presence of auricular fibrillation, but except for the digitalis effect the ventricular complexes were normal. Her temperature and respirations were normal.

Laboratory Findings.—The basal metabolic rate (June 18) was +2 per cent. The urine, blood count, Kahn and Kolmer reactions were all normal.

Treatment.—On June 18, 1935, at 2:00 P.M., the patient was given a "test" dose of 0.2 gm. (3 grains) of quinidine sulphate. When examined two hours later, the heart was found beating at a rate of 60 per minute, and the rhythm was entirely normal.

The following day the electrocardiogram (Fig. 4) confirmed the presence of sinus rhythm, and, but for slight digitalis effect, no deviation from the normal was indi-

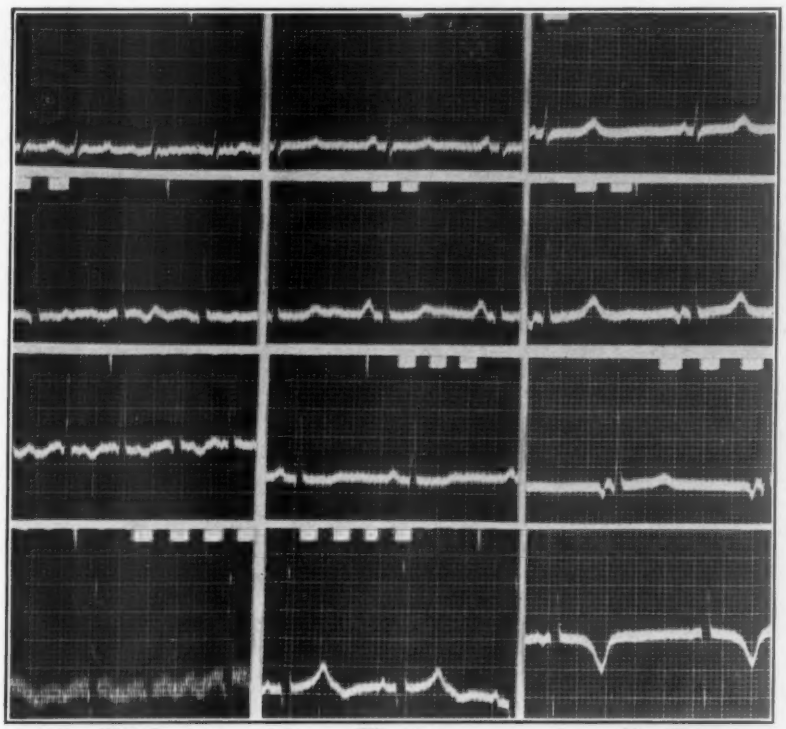

Fig. 3. Fig. 4. Fig. 5.

Fig. 3.—Electrocardiogram taken June 17, 1935, showing auricular fibrillation and some evidence of digitalis effect. Ventricular rate, 110.

Fig. 4.—Electrocardiogram taken June 19, 1935, showing sinus rhythm and some evidence of digitalis effect. Ventricular rate, 75.

Fig. 5.—Electrocardiogram taken July 11, 1935, showing normal tracing except for inverted P-waves in Leads II and III. Ventricular rate, 75.

cated. The same day the patient was sent home with instructions to take quinidine, grain ½, three times daily, for two days. Thereafter all medication was stopped, and recovery was rapid and uninterrupted.

Three weeks later (July 11, 1935) the patient walked into the hospital, climbing many stairs with no difficulty whatever. The heart was normal, and no murmurs were heard. The blood pressure was normal (systolic 130, diastolic 80). The radial pulse was of good quality, and the artery itself was too soft to be palpated. The retinal vessels appeared entirely normal. The electrocardiogram on that day

(Fig. 5) was normal except for inverted P-waves in Leads II and III. This alteration has never recurred and was not considered significant of any structural change. The digitalis effect had disappeared.

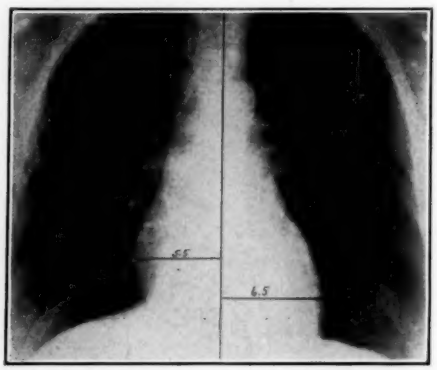

Fig. 6.—Film taken April 14, 1936, showing no passive congestion, and heart normal in size, shape, and position. Width of cardiac shadow is now 12 cm.

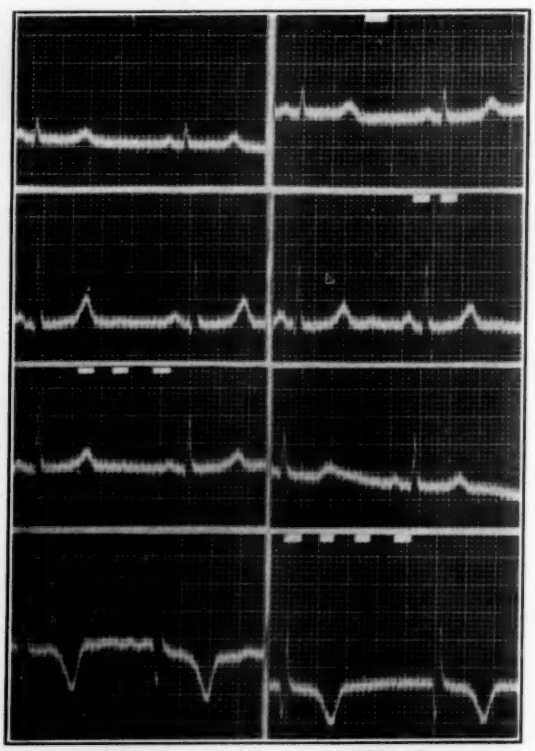

Fig. 7. Fig. 8.

Fig. 7.—Electrocardiogram taken April 14, 1936, showing normal tracing. Ventricular rate, 60.

Fig. 8.—Electrocardiogram taken April 29, 1936, showing normal tracing. Ventricular rate, 60.

From that day to the present (more than one year since all treatment was discontinued) the patient has lived an active life, involving the care of a home and

large social responsibilities, with no discomfort whatsoever. Her home is located on a hill, and she negotiates the climb without any difficulty. Repeated radiological and electrocardiographic examinations of her heart (Figs. 6, 7, 8) reveal normal findings. To ordinary physical examination and the usual tests for functional capacity, such as exercise and vital capacity determination, she always responds in a normal manner.

DISCUSSION

Auricular fibrillation is usually classified as persistent (or permanent) and paroxysmal (or transient). The former variety is regarded as the more serious and is more likely to be associated with grave organic heart disease. Clinically, the distinction between the two is based on the duration of the attack. Friedlander and Levine[3] regard an attack of fibrillation as persistent if it lasts longer than seven days, for it is assumed that if an attack lasts longer than seven days it is not likely to cease spontaneously. Parkinson and Campbell[1] in a series of 200 cases of paroxysmal fibrillation found that in only eight patients (4 per cent) one of the typical recurrent paroxysms lasted more than four days, and in only six of these were there attacks which lasted longer than one week. It seems, therefore, fair to classify the attack of fibrillation described above as belonging to the persistent variety; for it is definitely known that the heart was fibrillating on June 1, 1935, and from the available history, it appears highly probable that the attack began sometime in March, 1935.

The matter of etiology presents a more difficult problem. Although it is now well known that fibrillation of either variety may occur in an otherwise normal heart, the development in this case of severe congestive failure makes it necessary to consider every factor which is known to play a part in the genesis of this arrhythmia. Clinical and pathological studies by Frothingham,[5] Yater,[6] Cookson,[7] Brown,[8] Evans,[9] and others demonstrate that, while auricular fibrillation is not accompanied by specific or uniform pathological lesions, clinically the arrhythmia is most commonly associated with rheumatic valvular disease (especially mitral stenosis), hypertensive disease, and thyrotoxicosis. Peripheral arteriosclerosis and syphilis are much less important factors, and still less significant is coronary disease. An exception to the latter observation is the fairly common occurrence of transient fibrillation during the early course of acute coronary occlusion (Levine[10]).

A careful study of the case record under discussion furnishes convincing proof that the various clinicopathological conditions listed above, with which fibrillation is commonly associated, are not present in this instance. On the contrary, the evidence presented tends to establish the fact that apart from the fibrillation episode the heart in this case is apparently normal. This fact in itself is not unusual, since, as was shown by Parkinson and Campbell,[1] Friedlander and Levine,[3] and Orgain, Wolff and White,[4] between 6 and 15 per cent of all cases

of fibrillation are associated with hearts which are normal apart from the fibrillation. However, the extraordinary circumstance in this instance is the development of severe congestive failure, which is ordinarily regarded as indicative of grave organic heart disease. A comprehensive review of the literature yielded but one example comparable to this case. The instance referred to is that of Case 186 reported by Parkinson and Campbell.[1] Their patient was a man who "had tonsillitis as a child, but never acute rheumatism, or any serious illness. When twenty-three (1912) he awoke one morning with severe palpitation, breathlessness, and weakness. His doctor found nothing abnormal except the rapid irregular pulse, which he attributed to the strain of hunting, and kept him in bed for a month though the pulse was regular after two days. From 1913 to1918 he had only five more attacks, each lasting for some hours, and he was able to serve as a combatant officer in France. He remained well enough to lead a normal life until 1920 when fibrillation started again as he was running upstairs. A week later an EC showed fibrillation, with a ventricular rate of about 100. Fibrillation persisted, but there were no signs of failure, and he was able to get about with few restrictions. In 1922, after three days' fever (influenza?), he became very ill with heart failure. The ventricular rate was 180; he had Cheyne-Stokes breathing and seemed to be dying. With intravenous strophanthin he gradually improved and left his bed three weeks later. He continued to take digitalis, but was more or less an invalid, having to give up all sports. In 1925, in the fifth year of persistent fibrillation, he was treated with quinidine by Dr. Cotton and his heart became regular on the sixth day. In 1930, after another five years of normal rhythm, he wrote: 'I was soon able to resume my normal activities, and have continued hunting and playing tennis, hockey, and polo matches without any trouble whatever.' His present capacity for exertion and the absence of signs demonstrate that his heart is sound functionally; no doubt his dangerous illness in 1922 was due to a temporary general infection, but his condition at other times from 1920 to 1925 shows how much disability may be produced by fibrillation, apart from any other disease of the heart."

The significant point in this remarkable story is the fact that although he continued to take digitalis, this patient was practically an invalid for five years (from 1920 to 1925). But by means of quinidine, even after five years of persistent fibrillation, he was restored to apparently perfect health.

It seems quite probable that our patient, had she been treated with digitalis alone, might also have remained chronically incapacitated. Friedlander and Levine[3] have pointed out that in established fibrillation digitalis is practically never effective in restoring normal rhythm. There appears to be little reason to doubt that the small quantity of

quinidine administered to this patient was the *remedium magnum* in this case. This is worth emphasizing, since quinidine is considered (and rightly so) as being contraindicated, or at least without significant benefit, in the presence of serious organic heart disease (Kohn and Levine[11]); and congestive failure is usually regarded as signifying the presence of such cardiac pathology. The experience with this case illustrates the importance of seeking to establish in patients with fibrillation the presence or absence of organic heart disease, and of bearing in mind that congestive failure of even severe degree may develop in either instance and must not be regarded of itself as necessarily indicative of organic or structural change.

The onset of the arrhythmia in this case might have been related to the "sinus trouble" suffered by the patient in January, 1935. There was "slight fever" associated with that attack, and the patient frequently remarked that she had never felt quite well since that illness. "Infection" and "toxic" conditions were thought by Parkinson and Campbell[1] to have been possible etiological factors in 12 of their 30 patients with fibrillation and otherwise normal hearts. In the remaining 18 patients, there was no apparent cause. In a similar group of 35 patients studied by Friedlander and Levine[3] gastrointestinal disturbances, alcohol, and upper respiratory infections were deemed the inciting factors in 15 cases, but no ascribable cause was discernible in the remaining 20 patients. In the 49 cases reported by Orgain, Wolff, and White,[4] the onset of the arrhythmia in some of the patients appeared to "be related to pneumonia, malarial chill, pelvic abscess, alcohol, ether, burns, gallbladder colic, vomiting, surgical operation, exertion, and emotion." However, in many of the cases there were no definite etiological factors.

The rapid response of our patient to the single dose of 0.2 gm. of quinidine is not without example. Kohn and Levine[11] have pointed out that there was no constant ratio between the duration of the arrhythmia, the clinical condition of the patient, and the amount of quinidine necessary to produce a normal rhythm. They found 0.2 gm. of quinidine sufficient in one patient with moderate cardiac enlargement and congestive failure, in whom fibrillation was known to have existed for two and one-half months. In another patient whose arrhythmia was of but a few days' duration 10.5 gm. of the drug were required to restore normal rhythm.

PROGNOSIS

The outlook in patients with fibrillation without other evidence of heart disease appears quite favorable. The mortality from the arrhythmia or from subsequently developing cardiac disease is negligible.[1, 3, 4] This is in striking contrast to the grave prognosis held by patients with fibrillation and advanced organic heart disease. The

average duration of life in the latter is from two and one-half to seven years (Cookson[7] and Stroud, Laplace, and Reisinger[12]). It should be noted, however, that this grave outlook is governed chiefly by the underlying cardiovascular disease and is perhaps only slightly augmented by the presence of the arrhythmia.

SUMMARY

The report of a case is presented, with evidence tending to prove that auricular fibrillation in an otherwise normal heart may of itself cause severe congestive failure. Diagnosis, treatment and prognosis are discussed.

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THE USE OF CHEST LEADS IN CLINICAL ELECTROCARDIOGRAPHY

I. Normal Variations*

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In 1932 Wolferth and Wood[1, 2] reintroduced chest leads as an adjunct to the three standard leads in clinical electrocardiography. They claimed that additional information could thereby be gained in certain cases. In America and on the continent this revival was followed by many enthusiastic reports, some of which have been sharply criticized by Roth[3] in a recent review of the subject. There is still lack of agreement as to which chest leads yield the most information, as to the limits of normal variation of electrocardiograms obtained with these leads, and indeed as to the value of chest leads at all. It was with the hope of clarifying these three points that the present work was undertaken.

It has been shown[4, 5, 6] that, when one electrode (the exploring electrode) is applied over the anterior chest wall in the region overlying the heart, differences of electrical potential arising within the heart may be recorded, which differences are but little influenced by the position of the other electrode (the indifferent electrode). Wolferth and Wood[1] originally placed their exploring electrode over the apex beat, and their indifferent electrode over the posterior chest wall medial to the angle of the left scapula. They called this Lead IV. In Lead V they shifted the indifferent electrode to the left leg. Subsequent investigators have noted no important differences between these two leads, and Lead V has the advantage of greater simplicity. Different electrocardiograms are obtained, however, if the exploring electrode is shifted to the right of the apex beat, and we therefore decided to confine our attention to the exploring electrode, fixing the indifferent electrode to the left leg or to the right arm.

The procedure was simple. After recording the three standard leads, the left arm electrode was transferred to the apex beat and was coupled first with the right arm and then with the left leg. The exploring electrode was then moved to a point midway between the apex beat and the midline at the level of the fourth intercostal space and subsequently over the right border of the sternum at the same

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level, on each occasion being coupled first with the right arm and then with the left leg. Thus nine leads were employed with each subject, three standard leads and six chest leads.

In a later paper the clinical value of each of these leads will be discussed on the basis of a series of pathological subjects; the present report deals only with the presentation of the limits of normal variation of electrocardiograms obtained with these leads in 150 normal individuals.

Small silver electrodes, measuring 2 by 1½ inches, were used, and skin resistance was reduced by means of a special paste. All records were obtained with the Standard Cambridge Electrocardiograph, the subjects being placed in the recumbent position, and the usual standard calibration being employed.

TABLE I

ANALYSIS OF 114 NORMAL CONTROLS—STANDARD LEADS

LEAD	P-WAVE		P-R (SEC.)	Q (MM.)	R (MM.)	S (MM.)	QRS DURATION (SEC.)	T (MM.)	S-T DURATION (SEC.)
	HEIGHT (MM.)	DURATION (SEC.)							
Lead I									
Average	0.9	0.075	0.15	1.0	6.8	2.5	0.07	2.8	0.28
Maximum	2.0	0.1	0.21	3.0	17.0	7.0	0.09	4.0	0.36
Minimum	0.3	—	0.10	0.5	2.0	0.5	0.04	1.0	0.20
Absent	2			53		14			
Lead II									
Average	1.3	0.08	0.16	1.1	11.5	2.5	0.075	3.3	0.29
Maximum	3.0	0.10	0.22	2.5	22.0	10.0	0.10	8.5	0.37
Minimum	0.5	—	0.12	0.4	4.0	0.5	0.05	1.0	0.24
Absent	4			55		16			
Lead III									
Average	+0.8 -0.6	0.07	0.155	2.1	7.4	2.2	0.07	+1.3 -1.1	0.28
Maximum	+1.5 -1.0	0.09	0.22	2.5	18.0	6.0	0.10	+3.0 -2.0	0.33
Minimum	—	0.10	—	0.5	1.5	0.5	0.04	—	0.22
Absent				59	1	48			

In Lead III:	*Positive*	*Negative*	*Biphasic*	*Isoelectric*
P-wave	71	12	7	24
T-wave	77	15	1	21

RESULTS

The investigation was carried out upon 150 normal subjects ranging in age between five and seventy years, there being 100 children under sixteen years of age and 50 adults. There were 129 males and 21 females. The electrocardiograms obtained with the standard leads were within the accepted limits of normal variation. Eleven showed slight axis deviation, ten left and one right. Slight slurring or notching of QRS was common at the base and in the lead of lowest voltage,

TABLE II

ANALYSIS OF CHEST LEADS FROM 114 NORMAL SUBJECTS

LEAD	P-WAVE HEIGHT (MM.)	P-WAVE DURATION (SEC.)	P-R (SEC.)	Q (MM.)	R (MM.)	S (MM.)	QRS (SEC.)	T (MM.)	S-T (SEC.)	RS-T TAKE-OFF ELEV. (MM.)	RS-T TAKE-OFF DEP. (MM.)	RS-T TAKE-OFF ISO.
Apex—right arm lead												
Average	1.4	0.08	0.17	1.5	15.8	7.4	0.07	6.9	0.29	0.8	0.7	
Maximum	2.5	0.1	0.22	5.0	23.0	17.0	0.10	14.0	0.36	2.0	1.0	
Minimum	—	—	0.10	0.5	1.5	2.0	0.05	3.0	0.24	—	—	
Present	113			25	114	114				47	4	63
Apex—left leg lead												
Average	+0.6 −0.6	0.05	0.15	10.5	8.7	0.5	0.07	−4.0	0.29	0.6	0.7	
Maximum	+1.0 −2.0	0.08	0.22	18.0	17.0	0.5	0.1	−15.0	0.34	1.0	1.2	
Minimum	—	—	0.08	2.0	1.0	0.5	0.05	−0.5	0.24	—	—	
Present	23+ 49− 8±			114	114	2				5	34	75
Left pectoral—right arm lead												
Average	0.8	0.08	0.16	1.2	11.3	9.8	0.08	5.2	0.29	0.8	0.7	
Maximum	2.0	0.12	0.22	1.5	25.0	17.0	0.10	15.0	0.35	2.0	1.0	
Minimum	0.5	—	0.10	1.0	2.0	4.0	0.06	2.0	0.24	—	0.5	
Present	114			2	114	114				61	0	53
Left pectoral—left leg lead												
Average	+0.8 −0.5	0.05	0.16	6.4	11.8	0.7	0.08	−2.8 +1.8	0.28	0.6	0.7	
Maximum	+2.0 −1.0	0.08	0.22	15.0	20.0	1.0	0.10	−14.0 +3.5	0.34	1.0	2.0	
Minimum	—	—	0.08	1.0	4.0	0.5	0.06	—	0.22	—	—	
Present	20+ 55− 15± 24 iso.			114	114	2		13+ 85− 16±		0	53	61
Right pectoral—right arm lead												
Average	1.2	0.08	0.16	—	7.5	9.2	0.08	3.0	0.28	0.7	0.3	
Maximum	2.0	0.10	0.22	—	17.0	18.0	0.10	8.0	0.35	2.0	0.3	
Minimum	0.2	—	0.10	—	1.0	2.0	0.06	0.5	0.24			
Present	114			0	114	114				46	0	68
Right pectoral—left leg lead												
Average	+0.9 −0.6	0.05	0.16	4.7	12.4	1.0	0.08	+2.0 −2.0	0.28	1.2	0.6	
Maximum	+1.5 −1.0	0.08	0.22	11.0	25.0	1.0	0.10	+3.5 −5.0	0.32	2.0	1.5	
Minimum	—	—	0.08	0.5	0.8	—.	0.06	—	0.22	0.5	—	
Present	14+ 59− 32± 9 iso.			114	114	2		54+ 35− 23± 2 iso.		0	44	70

but occurred only once at or near the apex of the maximum QRS deflection. M or W complexes were seen 16 times in Lead III but did not occur in other leads. A more exact analysis of 114 of the cases is presented in Table I.

An analysis of the records obtained with the six chest leads upon the same 114 cases is presented in Table II. No electrocardiograms were rejected because their deflections failed to fall within the limits of normal as given by other authors.[1, 5, 7-13]

We agree with these authors that for the apex-left leg lead (the electrodes being arranged so that relative negativity of the exploring electrode gives an upward deflection on the electrocardiogram) the common appearances include (Fig. 1).

1. A very small frequently inverted P-wave.
2. A prominent Q-wave.
3. A biphasic QR complex with no S-wave.
4. A large sharply inverted T-wave.

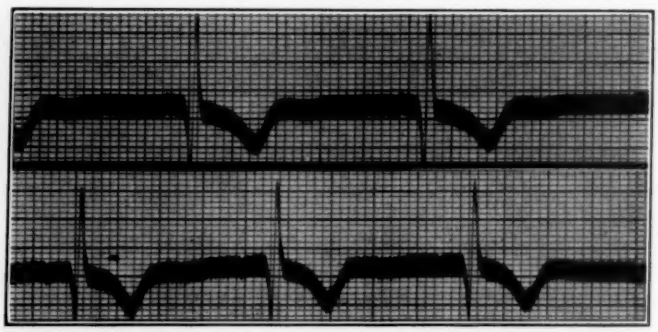

Fig. 1.—Common appearances of apex—left leg leads.

We do not agree with certain authors[8, 9, 10] in respect to the criteria which they have laid down as evidence of abnormality. If chest lead electrocardiography is to be of help, it is essential to appreciate the variations of normal. For this reason we have deemed it wise to deal with some of these criteria in detail.

A. An Upright P-Wave.—Table III shows that an upright P-wave is common.

TABLE III

P-WAVE IN 114 NORMAL CONTROLS

LEAD	POSITIVE	NEGATIVE	BIPHASIC	ISOELECTRIC
Apex—left leg	23	49	8	34
Left pectoral—left leg	20	55	15	24
Right pectoral—left leg	14	59	32	9

In the right arm coupled leads the P-wave was always upright. It is worth noting that P never exceeded 2.5 mm. in height in any lead. The right pectoral lead has been called the auricular lead. This

is presumably because, in certain cases of mitral stenosis the P-waves, and in certain cases of auricular fibrillation the *f*-waves, are unusually large in this lead; but they are not large in normal controls.

B. A Very Small Q-Wave or Nearly Monophasic QRS Complex[10] (Figs. 2 and 3).—Our minimum normal Q-wave was 2 mm. in depth in the apex—left leg lead, and was 1 mm. in depth in the left pectoral —left leg lead. When the main QRS deflection was downward, our minimum upward deflection was 1 mm. in height. It would therefore appear wiser to consider abnormal only an absolutely monophasic de-

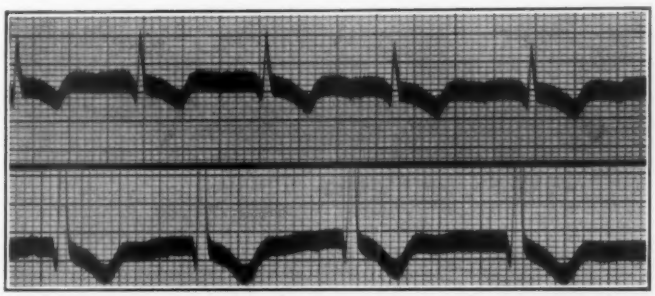

Fig. 2.—Apex—left leg leads. Note small Q-waves.

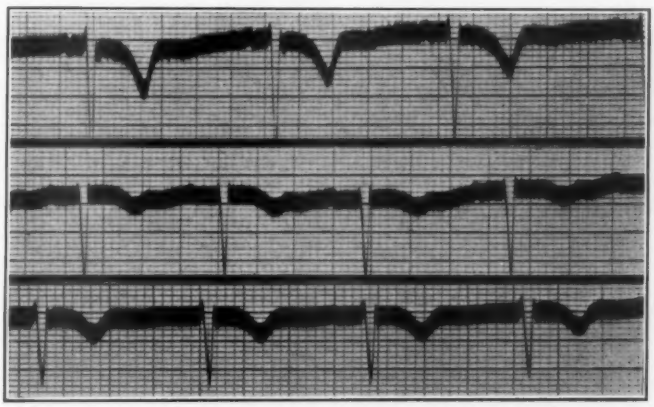

Fig. 3.—Apex—left leg leads. Almost monophasic downward deflections.

flection which did not occur once in our series of 150 cases, nor in any other series of normal controls reported.

C. Notching of the QRS Complex[5, 7, 8] (Fig. 4).—We agree with Shipley and Hallaran,[13] and with Master and his coworkers[15] that this is a normal variation. In our series of 150 controls, notching, which did not include slurring, occurred in one or more leads in 52 subjects, or in 34 per cent, and bore no relationship to notching in the standard leads. Its incidence in the various leads is given in Table IV.

TABLE IV

DEFLECTION NOTCHED	LEAD					
	APEX—R. ARM	APEX—L. LEG	L. PECT.—R. ARM	L. PECT.—L. LEG	R. PECT.—R. ARM	R. PECT.—L. LEG
Q	0	10	0	9	0	1
R	1	4	1	14	4	18
S	0	0	1	0	3	0

D. M or W Complexes.[10]—Again we agree with Shipley and Hallaran,[13] and with Master and his coworkers[15] that these are not uncommon normal variations. These writers described a small initial

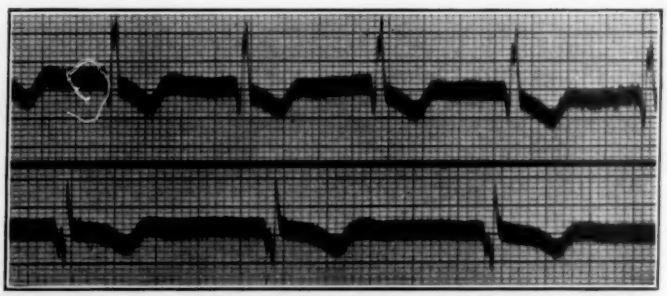

Fig. 4.—Notching in apex—left leg leads.

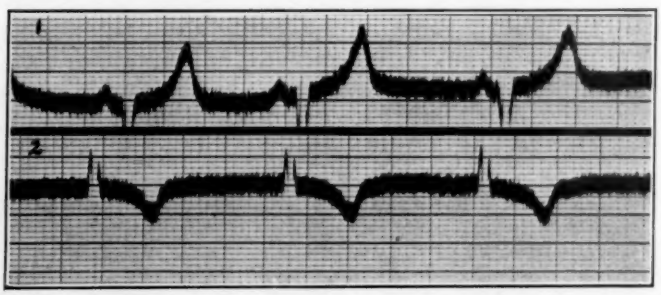

Fig. 5.—*1*, Apex—right arm lead, initial downward deflection; *2*, apex—left leg lead, initial upward deflection.

upward deflection preceding what would otherwise have been a normal Q-wave in the apex—left leg lead. We found this extra deflection in 20 out of 150 cases in the apex—left leg lead and its counterpart, an initial downward deflection, in 30 out of 150 cases in the apex—right arm lead. In the other leads it was rare. An example of this extra deflection is shown in Fig. 5.

E. Elevation of the R-T Segment[8, 9, 10] (Fig. 6).—There have been frequent allusions to the normal depression of the R-T segment in the apex—left leg lead, the limit of which has been drawn at 2 mm. Elevation of any degree has been considered abnormal. By means of

a special electrode paste we were able to reduce skin resistance sufficiently to ensure a tight string so that overshooting was avoided. With this technic 66 per cent of our 114 analyzed cases showed an isoelectric R-T take-off in the apex—left leg lead, and in another 18 per cent the depression measured only 0.5 mm. from the isoelectric line. Depression of more than 1 mm. occurred in only one case in this lead. The findings in the other leads are tabulated below.

Slight elevation of the R-T take-off in the apex—left leg lead was found in five cases, or in 4.4 per cent. It amounted to more than 0.5 mm. in only one instance when it measured 1 mm. In standard Lead II slight elevation of the S-T take-off was found in 6 per cent of 150 cases and measured 0.5 mm. in all but one, in which it was 1 mm. In standard Leads I and III deviation of the S-T take-off was a little less frequent, and in all three leads elevation was more common than depression.

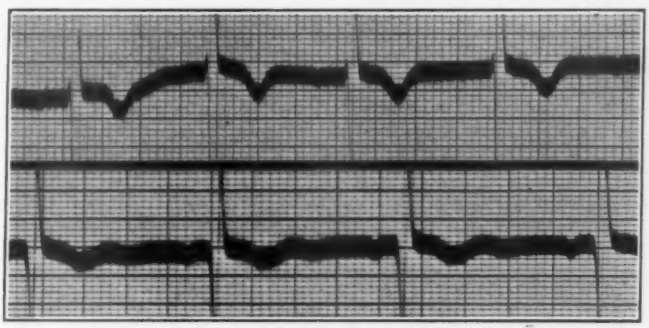

Fig. 6.—Apex—left leg leads. Slight elevation of the R-T take-off.

TABLE V

R-T OR S-T TAKE-OFF (114 CONTROLS)

DEVIATION FROM THE ISOELECTRIC LINE	LEAD					
	APEX—R. ARM (ELEV.)	APEX—L. LEG (DEP.)	L. PECT.—R. ARM (ELEV.)	L. PECT.—L. LEG (DEP.)	R. PECT.—R. ARM (ELEV.)	R. PECT.—L. LEG (DEP.)
nil	63	75	53	61	68	70
0.5 mm.	15	21	25	30	22	31
1.0 mm.	28	12	33	21	21	13
1.5 mm.	2	0	1	1	1	0
2.0 mm.	2	1	2	1	2	0

NOTE.—Four cases in the apex—right arm lead showed slight depression. Five cases in the apex—left leg lead showed slight elevation.

F. T-Wave of Greater Amplitude Than 9 mm.[8, 9, 10] (Fig. 7).—Our maximum T-wave measured 15 mm. in amplitude, and there were several over 10 mm. There was no reason to suppose that these large T-waves were abnormal.

G. Biphasic or Isoelectric T-Waves.[10]—Before considering the normal variations of the T-wave in chest-lead electrocardiograms, it is necessary to understand the effects produced by shifting the exploring electrode. The effect upon the QR complex has been noted by Hoffman

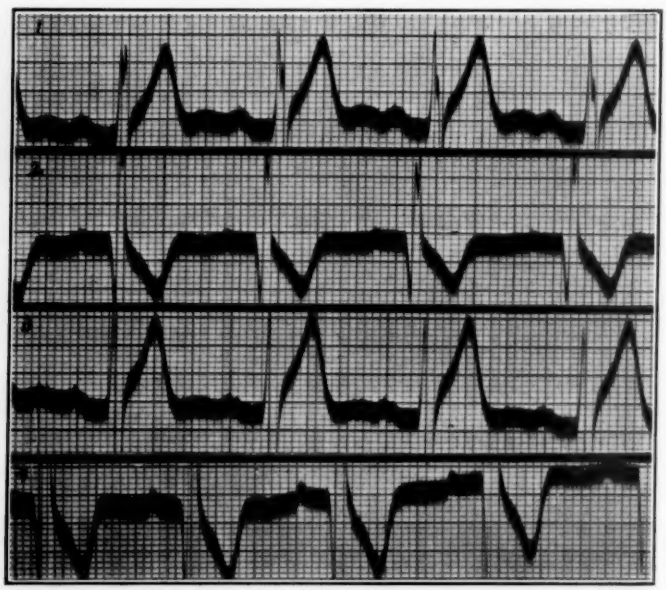

Fig. 7.—Large T-waves. *1*, Apex—right arm lead; *2*, apex—left leg lead; *3*, left pectoral—right arm lead; and *4*, left pectoral—left leg lead.

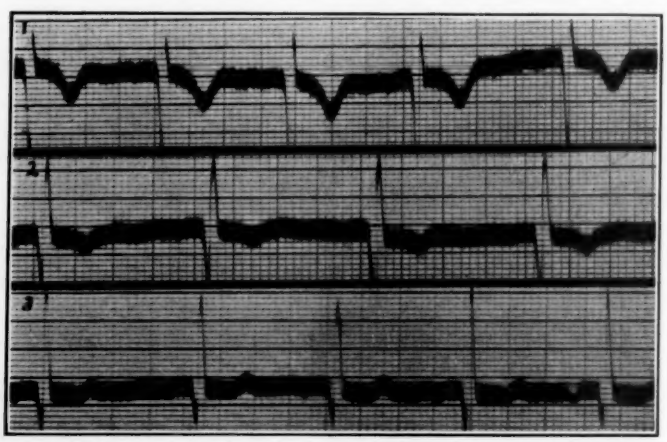

Fig. 8.—Showing the effect of shifting the exploring electrode. *1*, Apex—left leg lead; *2*, left pectoral—left leg lead; and *3*, right pectoral—left leg lead.

and Delong,[6] by Shipley and Hallaran,[13] by Kossmann and Johnston,[16] and others. In the majority of instances it is found that, in a normal subject with the electrodes arranged so that relative negativity of the exploring electrode results in an upright deflection on the electro-

cardiogram, a lead taken from some point overlying the heart yields a truly biphasic QR complex with Q equal to R in amplitude, and that, within certain limits, shifting the exploring electrode to the right results in a relatively smaller Q and in a relatively larger R-wave, whereas shifting it to the left has the opposite effect (Fig. 8).

From a clinical point of view a more important effect of this shift is the alteration in size, shape, and direction of the T-wave[15] (Fig. 8). Table VI illustrates this effect in 86 normal children between eight and sixteen years old and in 50 normal adults.

It may be seen that in no instance was the T-wave upright in the apex—left leg lead, although it was biphasic in six children. On shifting the exploring electrode to the right, the T-wave tended to

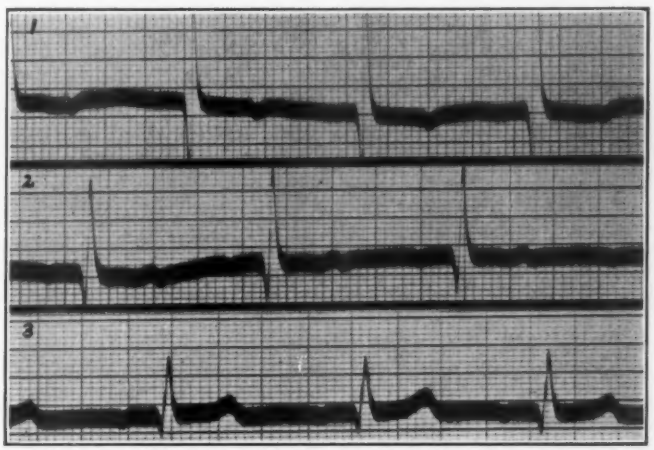

Fig. 9.—*1*, Apex—left leg lead; *2*, left pectoral—left leg lead; and *3*, right pectoral—left leg lead. T biphasic in apex—left leg lead.

become upright; thus in the left pectoral lead it was biphasic in 18 per cent and was upright in 21 per cent of the children and in two slim young female adults; and in the right pectoral lead it was upright in 65 per cent of the children and in 58 per cent of the adults.

TABLE VI*

LEAD	DIRECTION OF THE T-WAVE		
	INVERTED	BIPHASIC	UPRIGHT
86 Normal Children			
Apex—left leg	80	6	nil
Left pectoral—left leg	52	16	18
Right pectoral—left leg	20	10	56
50 Normal Adults			
Apex—left leg	50	nil	nil
Left pectoral—left leg	48	nil	2
Right pectoral—left leg	17	4	29

*Figs. 9 to 12 show the possible combinations of upright and inverted T-waves in the three left leg coupled leads.

If the T-wave showed any tendency to become upright in one lead, it was invariably more upright on shifting the exploring electrode to the right. These findings agree fairly well with those of Rosenblum and Sampson,[12] who noted an upright T-wave in 34 out of 50 normal children between the ages of one month and sixteen years, for these authors placed their exploring electrode at the left border of the sternum.

It is well known that inversion of the T-wave in the third standard lead is often associated with a horizontal position of the heart consequent upon a high diaphragm. In view of this we decided to determine if the position of the heart in relation to the thorax was in any way related to the behavior of the T-wave in chest lead electrocardiograms. For this purpose a group of 86 schoolboys was studied. Of these, 72 were selected for fluoroscopy and were divided into three groups according to their electrocardiograms. In Group 1 there were 18 boys in whom the T-wave was upright in both left and right pectoral—left leg leads; in Group 2 there were 36 in whom T was upright only in the right pectoral lead; and in Group 3 there were 18 in whom T remained inverted in the right pectoral lead. Obviously the radiological appearances of all these hearts were within the limits of normal variation and an estimation of their relative sizes and shapes was entirely a question of judgment. Of 5 pendulous hearts none were seen in Group 3; of 7 hearts characterized by an exaggeration of the pulmonary arc, none occurred in Group 3, whereas 4 were from Group 1; in contrast, of nine transverse hearts associated with a high diaphragm, 5 were from Group 3; and of 13 relatively large hearts, 6 occurred in Group 3 against only 2 from Group 1. Thus in Group 3, 10 out of 18 had either relatively large hearts or transverse hearts associated with a high diaphragm, as compared with four out of eighteen in Group 1. If any conclusions can be drawn from these findings, it would appear that an upright T-wave in the left pectoral—left leg lead tends to be associated with small or with pendulous hearts, or with hearts characterized by an exaggeration of the pulmonary arc, whereas a T-wave which remains inverted in the right pectoral—left leg lead tends to be associated with relatively large hearts or with transverse hearts associated with a high diaphragm. If this be true, then T should be inverted in the right pectoral—left leg lead in cases of hypertensive heart disease and of aortic valvular disease, and it should be upright in the left pectoral—left leg lead in cases of mitral stenosis and of heart disease secondary to emphysema. So far as our investigations have proceeded in pathological subjects, this rather appears to be the case.

The configuration of the chest was also studied in the group of 86 schoolboys. Anteroposterior and lateral external measurements were obtained by means of obstetrical calipers; the subcostal angle was

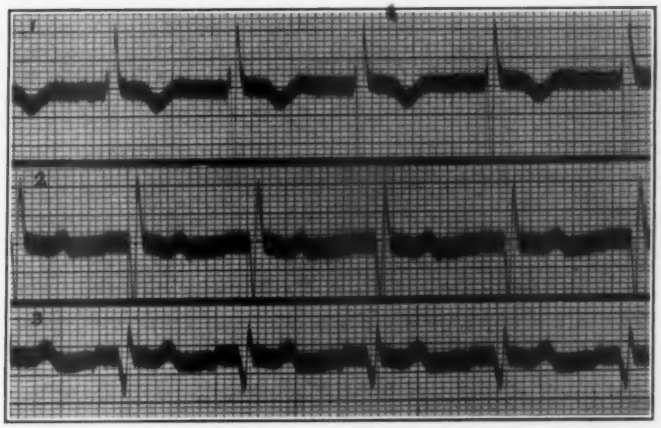

Fig. 10.—*1*, Apex—left leg lead; *2*, left pectoral—left leg lead; and *3*, right pectoral—left leg lead. T upright in left pectoral—left leg lead but inverted in the apical lead.

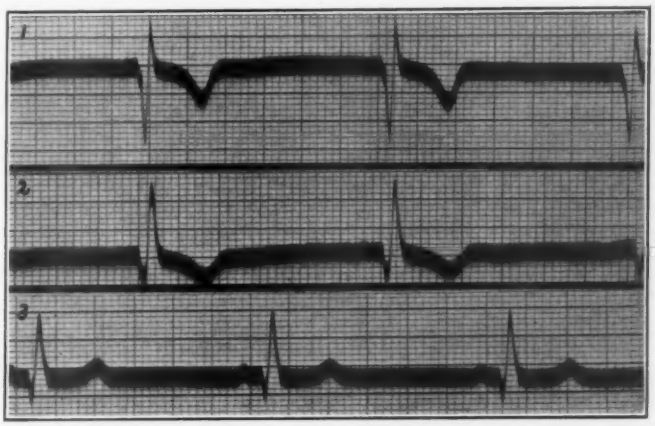

Fig. 11.—*1*, Apex—left leg lead; *2*, left pectoral—left leg lead; and *3*, right pectoral—left leg lead. T upright only in the right pectoral lead.

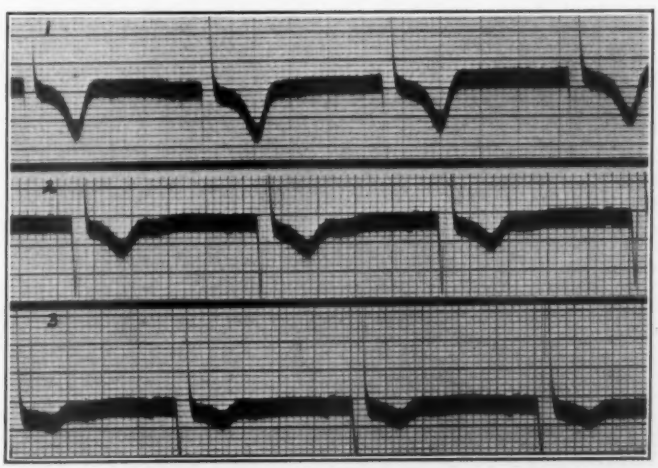

Fig. 12.—T inverted in all three leads. *1*, Apex—left leg lead; *2*, left pectoral—left leg lead; and *3*, right pectoral—left leg lead.

measured; the length of the thorax was better gauged by means of x-ray films; the height and weight of each boy were measured. The results permitted a certain grouping, and an attempt was made to ascertain if any particular group or combination of groups showed a similar behavior of the T-wave in the chest lead electrocardiogram. Apart from the fact that the three fattest boys showed an inverted T-wave in the right pectoral—left leg and that no slim boys showed this, no correlation could be found.

We may now consider the normal variations of the T-wave in chest lead electrocardiograms. We agree that an upright T-wave is abnormal in the apex—left leg lead in subjects over eight years of age, but in leads internal to the apex beat upright or diphasic T-waves are common normal variations, particularly in children under sixteen years of age. Before interpreting an upright T-wave as evidence of abnormality it is necessary to check the position of the exploring electrode.

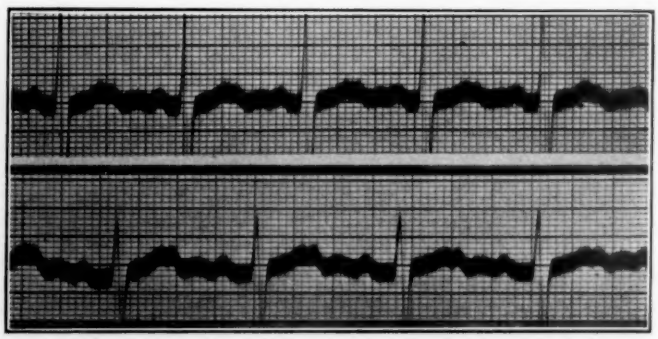

Fig. 13.—Bifid T-wave. Right arm—left pectoral leads.

There are two other points about the T-wave: first, from its point of origin the S-T or R-T segment ran almost immediately into the upright or inverted T-wave when this was large, but in other instances there was an appreciable isoelectric interval. Second, the T-wave was bifid in 15 records, usually in the left pectoral—right arm lead (Fig. 13).

SERIAL CHEST LEAD ELECTROCARDIOGRAMS

It follows from what has been said that in chest lead electrocardiography no two records are comparable unless the exploring electrode is in exactly the same position on both occasions. Levy and Bruenn[8, 9] have found serial chest lead electrocardiograms useful in following the activity of cases of rheumatic carditis, and they state, "By far the most frequently observed changes in Lead IV were alterations in the direction or voltage of the T-wave." Now these are just the changes which occur on slight shift of the exploring electrode which in their cases was placed close to the left border of the sternum, and

we should place no reliance on such changes unless some means were adopted whereby the position of the exploring electrode relative to the underlying heart could be exactly controlled, for more than due care is needed.

RIGHT ARM COUPLED LEADS

For the most part, the electrocardiograms obtained when the exploring electrode was coupled with the right arm were the reverse of those obtained with the left leg, being due to simple reversal of current through the galvanometer. This applied most strictly to apical leads but did not hold for the right pectoral leads. Now when the left arm electrode is used for the exploring electrode, the object in coupling it with the right arm electrode is to turn the QR complex into the more familiar RS complex and to bring the T-wave upright. Wolferth and Wood thought that this was optional, and Lieberson and Liberson preferred the more familiar appearances. It seems to us, however, that it is advantageous to be able to recognize a chest lead electrocardiogram at a glance and that therefore we should adhere to the more correct arrangement of Wolferth and Wood in which the connections are such that relative negativity of the exploring electrode yields an upward deflection on the electrocardiogram.

DURATION OF DEFLECTIONS

Reference to Tables I and II shows that the time limits adopted for the duration of the various phases of the standard lead electrocardiogram hold good for the respective phases of the chest lead electrocardiogram. The average duration of QRS, however, is slightly longer in the latter.

PRESENTATION OF NORMAL APPEARANCES

In conclusion we would represent the appearances of the chest lead electrocardiogram, with the leads arranged so that relative negativity of the exploring electrode produces an upward deflection on the record, as follows:

1. A small, frequently inverted P-wave, which may however be upright, biphasic, or isoelectric.

2. A biphasic QR complex which may be nearly all Q or nearly all R according to the position of the exploring electrode. An extra initial upward deflection may sometimes occur. Notching or slurring of any portion of the waves is common.

3. The R-T take-off is usually isoelectric but may be depressed to a maximum of 2 mm., or rarely may be slightly elevated.

4. There is commonly no appreciable isoelectric period of the R-T component unless the T-wave is small, biphasic, or upright.

5. The T-wave is usually sharply inverted and of considerable amplitude. Under certain conditions, especially in children, it may be upright or biphasic, according to the position of the exploring electrode.

6. Within certain limits shift of the exploring electrode to the right yields a relatively smaller Q-wave, a relatively larger R-wave, and a less inverted T-wave; shift of the exploring electrode to the left has the opposite effect.

SUMMARY

1. The normal appearances of chest lead electrocardiograms have been described from material recorded from 150 normal subjects. There were 50 adults and 100 children.

2. Particular attention has been paid to the position of the exploring electrode. The indifferent electrode was fixed to the right arm or to the left leg.

3. The changes which occur in the QR component as the exploring electrode is shifted from the apex beat to the right have been confirmed; more striking may be the change in the direction of the T-wave.

4. In view of the difficulty of fixing the exploring electrode in a constant position in relation to the underlying heart, great caution must be exercised in the interpretation of serial chest lead electrocardiograms.

5. An attempt was made to find some factor which might influence the direction of the T-wave when the exploring electrode was placed internal to the apex beat.

6. Certain criteria which have been supposed to denote abnormality have been criticized on the grounds that these may be normal variations.

NOTE.—No reference is made to the recent study by Drs. Robinow, Katz and Bohning (The Appearance of the T-Wave in Lead IV in Normal Children and in Children with Rheumatic Heart Disease, AM. HEART J. 12: 88, 1936) because that paper was published after the present study had been completed.

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HEART DISEASE AMONG SEAMEN*

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ABOUT a million alien seamen enter and leave the ports of the United States yearly; one-half of them pass through the port of New York. It is estimated that together with foreign and American merchant seamen there are as many as 20,000 seamen in the port of New York on an average day, coming and going to and from all parts of the world.[1] The greater part of all medical care of seamen ill in our ports is rendered by the United States Public Health Service through the Marine Hospitals which are situated at all important ports. There are as many as 3,000 admissions to the Marine Hospital at Ellis Island yearly and about as many to the Marine Hospital at Staten Island, while tens of thousands are treated yearly at the out-patient Marine Hospital at Hudson Street.

Heart disease is the leading cause of death among seamen, as it is among other groups of the population.[2] By their mode of life, economic status, strenuous occupation, habits, sex life, and geographic distribution, seamen make up a unique group for the etiologic study of heart disease. No other group presents such a diversification of known and theoretical factors in the etiology of heart disease. Any comparatively small group presents almost a complete cross-section of the population of the world. Syphilis, which is an important factor in heart disease, is probably more prevalent among seamen than any other group in this hospital.[3] Alcohol and tobacco, though not definitely established as etiologic agents in arteriosclerosis and hypertension, are at least theoretically considered as such by many.[4] More than 90 per cent of seamen smoke, many of them excessively, and more than 50 per cent of them are heavy drinkers, as observed in this hospital. If any of the above factors are at all influential in the etiology of cardiovascular disease, they are present here in abundance.

This study is based on a clinical investigation of 485 cases, including 50 autopsies, selected from over 5,000 seamen patients who had been subjected to a special cardiovascular examination regardless of the ailments for which they were admitted to the hospital. In almost every instance either a fluoroscopic examination or an x-ray film of the heart was made, and at least one electrocardiogram was taken. There were only 5 females. There were 45 colored males and 435 white males. Forty-one per cent of the group were native Americans, representing almost every state in the Union, and 59 per cent were foreign, coming from all parts of the world (Table I).

*From the United States Public Health Service.

TABLE 1

ETIOLOGIC CLASSIFICATION BY NATIONALITY

NATIVITY	HYPER-TENSIVE	RHEU-MATIC	ATHERO-SCLEROTIC	SYPH-ILITIC	MISCEL-LANEOUS	TOTAL
Australia	–	–	1	–	–	1
Austria	2	1	2	1	–	6
Argentina	1	–	–	–	–	1
Belgium	1	–	–	–	–	1
British West Indies	8	2	1	1	–	12
Canada	1	–	2	1	3	7
Cape Verde Islands	1	–	–	1	–	2
Chile	–	–	–	–	1	1
China	1	–	–	–	–	1
Cuba	–	1	–	–	–	1
Denmark	4	1	–	–	1	6
Dutch West Indies	2	1	1	1	–	5
England	13	4	8	2	2	29
Esthonia	–	1	1	1	–	3
Finland	–	1	2	–	–	3
France	2	–	1	–	–	3
Germany	18	2	6	4	1	31
Greece	8	1	1	3	–	13
Holland	1	1	1	2	1	6
Hungary	1	–	–	–	–	1
Ireland	8	2	5	1	1	17
Italy	7	6	4	2	1	20
Jamaica	1	–	–	–	–	1
Jugoslavia	2	1	–	1	–	4
Korea	–	1	–	–	–	1
Malta	1	–	–	–	–	1
Newfoundland	2	1	1	–	–	3
Norway	9	3	6	4	2	24
Palestine	–	–	–	1	–	1
Panama	1	–	–	1	–	2
Peru	1	–	–	–	–	1
Philippine Islands	–	1	1	–	1	3
Poland	3	4	–	1	1	9
Puerto Rico	1	2	–	3	2	8
Portugal	4	–	–	–	–	4
Roumania	2	–	–	2	–	4
Russia	1	2	–	–	2	5
Salvador	–	–	1	1	–	2
Santo Domingo	–	1	–	–	–	1
Singapore	–	–	–	–	1	1
Spain	4	2	2	2	1	11
Sweden	7	4	7	2	–	20
Syria	1	1	–	–	–	2
Turkey	1	–	–	–	–	1
Virgin Islands	2	–	–	–	–	2
Venezuela	1	–	–	–	–	1
United States	79	56	34	19	15	203
Total	201	102	88	57	36	485

Out of 485 patients 130, or 26 per cent, had active or latent syphilis; 44 per cent of these had cardiovascular syphilis. The prevalence of syphilis among the colored cardiac patients was 57 per cent and among the white cardiac patients 23.6 per cent. All patients in this study were adults ranging in age from nineteen to seventy-six years.

HYPERTENSIVE GROUP

The hypertensive group was the largest. Included in this group were those only in whom cardiac hypertrophy was demonstrated by x-ray film or fluoroscopic examination in addition to the presence of or history of hypertension. There were 202 patients, or 41.6 per cent, in this group; 21 were colored and 181 were white. Only 37 per cent were Americans. About 25 per cent were asymptomatic when first examined, and 14 per cent had either latent or active syphilis, while 26 out of 202 had coronary disease complications.

The age extremes were twenty-nine and seventy-six years, with the greatest number in the fifth and sixth decades of life.

RHEUMATIC GROUP

In this group there were 102, or 21.3 per cent; 55 per cent were Americans, in comparison with 37 per cent among the hypertensive group, and 41 per cent of the total number. There were 9 colored and 93 whites. The foreign group represented 24 different countries. Only a small number were from the tropical or subtropical regions, while 50 of 56 Americans were from the northeastern states. Sixty-nine had histories of rheumatic fever, and 11, histories of chorea.

The age extremes were nineteen and sixty-two years, the average age being thirty-five years, and the greatest number being in the third and fourth decades of life. There were 27 asymptomatic patients in this group, and 21 had latent or active syphilis, while 23 had auricular fibrillation.

ATHEROSCLEROTIC GROUP

In this group were included all cases of coronary disease, coronary thrombosis, myocardial damage, sclerosis of the aortic valve, and nonsyphilitic aneurysm. There were 88, or 18 per cent, in this group, representing 21 different countries, 38 being native Americans. The tropical and subtropical countries were almost entirely unrepresented. There were 4 colored and 84 whites.

The age extremes were thirty-seven and seventy-five years, the average age being fifty-seven years, and the greatest number being in the sixth and seventh decades. In contrast to the other groups there were only twelve asymptomatic cases. As a class of patients, seamen fall in the hyposensitive group with reference to pain. There were 2 aneurysms among the patients in this group.

CARDIOVASCULAR SYPHILIS

There were 57 patients, or 11.7 per cent of the total, in this group, 55 of whom had positive serology and 2 of whom had positive histories with negative serology. There were 10 colored and 47 whites. Twenty-six had had one or two courses of antisyphilitic treatment or none at all. There were 11 asymptomatic cases.

The age extremes were twenty-six and sixty-eight years, with an average age of forty-five years, the greatest number being in the fifth decade. There were 8 patients with aneurysm, only 2 of whom gave a history of antisyphilitic treatment prior to this observation.

MISCELLANEOUS GROUP

There were 36 cases under this heading. Among these were five cases of aortic insufficiency in which a history of rheumatic infection or syphilis could not be obtained. The etiology was thus considered as undetermined. There were six cases of auricular fibrillation without any other demonstrable cardiac disease.[5] The patients' ages were between forty-six and seventy-one years. All except one of these cases were asymptomatic.

There was one case of beriberi heart[6] and 6 of congenital cardiac lesions, with patent ductus and transposition. There were 3 cases of adherent pericarditis, one of which was considered Pick's disease. There were 2 cases of bacterial endocarditis, both being fatal. There were 2 cases of chronic cor pulmonale and 3 cases of paroxysmal tachycardia. In addition there were 6 thyroid heart conditions, in one of which auricular fibrillation was noted, and 2 cases of cardiac hypertrophy of undetermined cause.

Auricular fibrillation was the most frequent disturbance in rhythm. There were 49 cases of permanent fibrillation; 23 in the rheumatic group, 14 among the hypertensive group, 6 of undetermined origin, 5 in the atherosclerotic group, and one in the thyroid group. There were only 3 patients with auricular flutter, one established, the other two paroxysmal. One of the latter, which had been previously reported, showed 1:1 rhythm with a rate of 240.[7] There were 23 cases of heart-block, bundle-branch or mixed types; most of them were in the coronary group.

There were 71 deaths, 50 of which came to autopsy, distributed as follows: In the hypertensive group there were 29 deaths and 17 autopsies. Two had coronary thrombosis and two spontaneous rupture of the aorta. In the atherosclerotic group there were 21 deaths and 16 autopsies. Among the autopsied cases one had metastatic carcinoma of the myocardium obstructing the descending ramus of the left coronary artery. One had aortic stenosis and insufficiency considered as syphilitic insufficiency ante mortem, and one had an aneurysm. The others had various degrees of myomalacia from coronary obstruction or myocardial fibrosis from coronary atherosclerosis and insufficiency.

There were 13 deaths among the rheumatics, and 8 autopsies. One case, considered rheumatic mitral insufficiency, was found to have been congenital malformation of the mitral valve resulting in marked insufficiency. One other patient was found to have had syphilitic aortitis with insufficiency in addition to old mitral and aortic rheumatic endo-

carditis. The other six in this group which came to autopsy had mitral stenosis with insufficiency of various degrees. The remaining autopsied cases were two of acute endocarditis of staphylococcic origin, one with tuberculous pericarditis and one with chronic cor pulmonale. There were 7 deaths among the syphilitic cardiac patients and 7 autopsies; 3 had aneurysms, one ruptured, the others were cases of aortic insufficiency.

SUMMARY

Four hundred eighty-five cases of heart disease among seamen are presented. These men represent every continent and 49 different countries and islands. The incidence of heart conditions among seamen is as great as, if not greater than, among landsmen. Hypertension seems to be more frequent among seamen than among other groups in New York, and less frequent than it is in the Northwest.[8, 9] Rheumatic heart disease is about as frequent as among the general population, but American seamen are apparently more susceptible to it than seamen from other countries. The frequency of cardiovascular syphilis among seamen is two to three times as great as that among adult males of the general population.[8]

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THE DIPHASIC QRS TYPE OF ELECTROCARDIOGRAM IN CONGENITAL HEART DISEASE*

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WHILE there are a number of reports dealing with the electrocardiographic appearance of congenital heart disease, no characteristic picture has been described other than the occurrence of large voltage and axis deviation.[1-11] Of course, the mirror-image appearance of Lead I in certain cases of dextrocardia and the presence of heart-block and other abnormalities in the electrocardiogram are well known. Recently, we have seen several instances with a peculiar type of diphasic QRS complex in congenital heart disease. A survey of the literature failed to reveal any references to this peculiarity except for the casual mention by Talley and Fowler[12] that a diphasic QRS occurred in the case of congenital heart disease reported by them and their reference to several cases reported by Petit.

It was decided to make a more systematic survey of this peculiarity. For this purpose we have taken 43 typical cases of congenital heart disease from our Heart Station files. Of these, 11 were in their first year of life; 17 were between one and six years of age; 9 were between seven and fifteen years of age; and 6 were between twenty and forty-five years of age. The cases selected for this study had several of the following findings: a history of cyanosis at or near birth; the presence of "heart trouble" at this time; the presence of heart enlargement, cardiac murmurs, or thrills which could not be readily explained by an acquired lesion; and the finding of characteristic roentgenographic alterations. The electrocardiograms of these 43 cases were then analyzed in detail and the results tabulated.

RESULTS

The essential findings in the QRS and the abnormalities in the S-T segment and T-wave are summarized in Table I. There were 16 instances of right axis deviation and 5 of left axis deviation. In 13 instances the amplitude of QRS was large, being over 18 mm. in more than one lead (cf. Fig. 1). Marked slurring of QRS occurred in 13 instances, and in 7 of these the slurring occurred in all leads (Figs. 1 and 2). No abnormalities in rhythm were found in this series except for the occurrence of auricular premature systoles in one case. Abnormalities in the T-wave and the S-T segment were not common. T was tall in 10 cases, 6 cases in Lead II only, 1 in Lead I only, 1 in

*From the Heart Station, Michael Reese Hospital.

Lead III only, and 2 in both Leads II and III. T was small in 7 instances, 6 in Lead I only (cf. Fig. 1) and 1 in all leads. T was negative or diphasic in Leads I and II twice, both having mirror dextrocardia, diphasic in Leads II and III once (cf. Fig. 1) and negative in Lead I once. T was notched in 3 cases, twice in Lead I only,

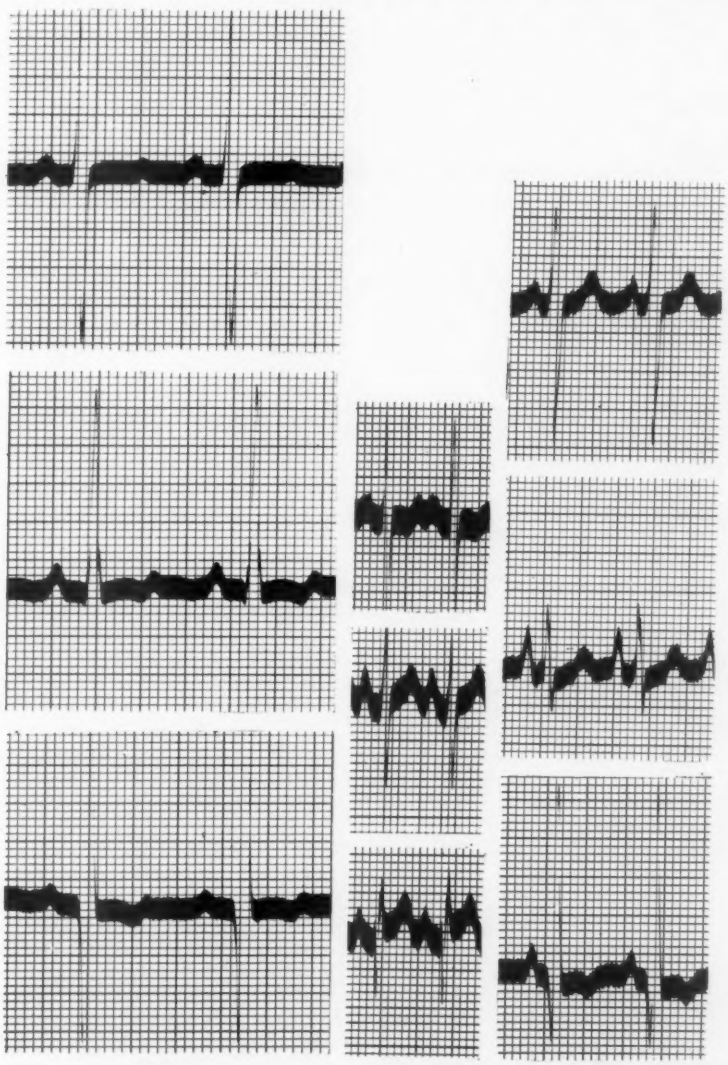

Fig. 1. Fig. 2. Fig. 3.

Fig. 1.—Note that in Lead III the diphasic QRS is not well reproduced; the first phase is negative, and the second is positive and taller than the edge of the print.

and once in all leads. S-T was negative in 7 cases, once in Lead I only (cf. Fig. 2), 3 times in Lead III only, once in Leads I and II, and 3 times in Leads II and III (cf. Figs. 1 and 3). S-T was abnormally positive in one case in Leads II and III (cf. Fig. 2).

While diphasic QRS complexes were very common, we have restricted the term diphasic QRS in this analysis to those diphasic QRS complexes in which the smaller phase had an amplitude of one-fourth or more of the larger phase. The data are assembled in Table I.

TABLE I

AGE	QRS AMPLITUDE IN MM.			T AND S-T CHANGES
	LEAD I	LEAD II	LEAD III	
3 days	+ 3 -10	+12	+18	T_1 small (aur. ext. syst.)
4 days	+ 5 - 5	+17	+15	T_1 tall S-T_3 neg.
14 days	- 8	+ 4 - 5	+ 8	
1 mo.[2]	+10 -12	+ 9 - 9	- 7 + 7	S-T_1 neg. S-T_2 and S-T_3 pos.
6 wk.	+ 5 -15	- 5	+ 3 -18	
2 mo.	+ 5 -12	+16 - 7	+21	T_3 tall
3 mo.	+ 6 -12	- 2 + 2	- 7 +12	T_3 tall
7 mo.[4]	+15 -10	- 2 +15 -7	- 8 +14	
9 mo.	+ 5	+ 4 -10 +1	+ 7 -15 +1	T_1 small
10 mo.	+ 6 - 4	+12	- 3 +12	T small all leads
1 yr.	+10 - 2	+18	- 2 +13	T notched all leads
18 mo.	+10 - 5	+20	- 4 + 8	T_2 and T_3 tall
18 mo.	+ 4	- 2 +20	+12	S-T_2 and S-T_3 neg.
20 mo.	- 2 +11	+14 -10	+ 9 -18	T_1 small and notched
2 yr.	+ 5 - 2	+10	+ 8	
2 yr.	+ 5 -10	- 6	- 7 + 8	
3 yr.	+ 9	+ 1 - 1	- 9	T_1 small
3 yr.	+ 8	+18	+ 8	
4 yr.	+ 3 -13	+10 - 3	- 3 +22	T_1 small and notched
4½ yr.	+ 4 -16	+ 8 - 3	+17	
5 yr.	+ 6 - 5	+12 - 3	+12	
5 yr.	+ 4 -16	+ 9 - 2	- 5 +14	T_2 and T_3 tall
5 yr.	+ 3 - 8	+ 9	- 2 +15	
5¼ yr.[3]	+11 -16	+ 8 - 3	- 8 +24	S-T_2 and S-T_3 neg. T_3 neg.
5½ yr.	+ 7 - 4	+ 7	+ 5	
6 yr.	+ 4 - 5	+22	- 4 +24	
6 yr.	+ 5 -13	- 1 +15 -6	- 2 +15	S-T_2 neg.
6 yr.	+ 9	+ 8 - 8	- 8	T_2 tall
8 yr.	+ 3 - 3	+10 - 5	+ 7	
9 yr.	- 5	- 3 +14	+24	
10 yr.	- 2 + 3	+14	+13	T_2 tall
11 yr.[1]	+20 -20	+25	-16 +23	T_1 tiny, T_2 and T_3 diphasic S-T_2 and S-T_3 neg. QRS duration 0.10
11 yr.	- 1 + 6 -5	+18	- 2 +15	
11 yr.	+10	+12 - 4	+ 6 - 8	S-T_1 and S-T_3 neg.
12 yr.	+11	+11	+ 2 - 3	T_3 tall
14 yr.	+ 4 - 3	+19 - 6	+15 - 8	
14 yr.	- 8	+ 8	+13	
23 yr.	+ 1 - 1	- 2 +15	- 1 +15	
25 yr.	- 2 +10	+15	+ 8 - 4	T_2 tall
25 yr.	-12	+ 3	+13	T_1 and T_2 neg. (dextrocardia)
25 yr.	+ 5 - 6	+ 6	+ 8	T_2 tall
32 yr.	- 1 +14	+14 - 1	+ 4 - 4	
44 yr.	- 8	- 8	+ 6 - 2	T_1 neg. T_2 diphasic (dextrocardia)

[1]Fig. 1.
[2]Fig. 2.
[3]Fig. 3.
[4]Fig. 4.

These diphasic QRS complexes were divided into two types; viz., the plus-minus where the first phase was upright and the minus-plus where the first phase was negative. When these diphasic QRS complexes occurred in more than one lead, they were again divided into two types of which the isocyclic was where the signs of the two phases were in the same order in the several leads and the heterocyclic where the signs of the two phases in one lead were the reverse of that in another.

There were 56 instances of diphasic QRS out of a possible total of 129: 26 in Lead I, 14 in Lead II, and 16 in Lead III. The plus-

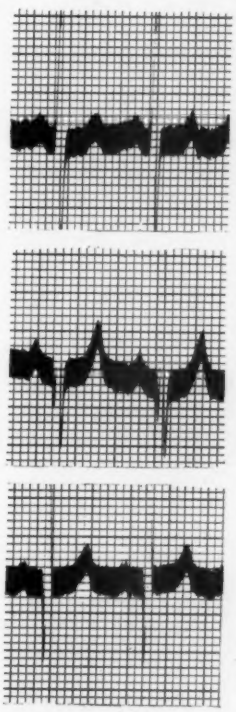

Fig. 4.

minus type was more frequent; viz., 45 instances, 25 in Lead I, 13 in Lead II, and 7 in Lead III. The minus-plus type was less frequent; viz., 11 instances, 1 each in Leads I and II, and 9 in Lead III. Diphasic QRS complexes occurred in more than one lead in 17 cases; in 5 in Leads I and II, in 6 in Leads I and III; in 2 in Leads II and III; and in 4 in all leads. Isocyclic types occurred in 8 cases, one involving all leads, the others Leads I and II or Leads II and III. Heterocyclic types occurred 9 times, 3 involving all leads and 6, Leads I and III. The isocyclic types were all of the plus-minus type. The heterocyclic type had a plus-minus in Lead I and a minus-plus in Lead III.

Several of the more striking examples of these diphasic QRS complexes are shown in Figs. 1 to 4. It is our impression that when changes as marked as those shown in these illustrations are seen, they are pathognomonic of congenital heart disease. Less marked examples in children should arouse suspicion and can be used as confirmatory evidence. Diphasic QRS complexes occur in the absence of congenital heart disease, notably in coronary artery disease (Leads I and III) and in left axis deviation (Lead II). A diphasic QRS in precordial leads is a normal finding. Normal children show diphasic QRS complexes as often as monophasic, triphasic or polyphasic, but a diphasic QRS with the two phases bearing a ratio of less than 1 to 4 is exceptional, if it occurs at all. Hence, it is of diagnostic value in congenital heart disease. In our small series this diphasic QRS was not found associated with any particular type of congenital heart disease.

The mechanism behind the diphasic QRS is unknown, and for the present it is not justifiable to speculate about its cause. It would seem, however, that it might well be a persistence of the embryonic pattern of invasion of the ventricles which would be more likely to persist in hearts whose development was partially checked in the form of other congenital defects.

SUMMARY

A diphasic QRS (with the size of the two phases being of the order of less than 1 to 4) was a frequent finding in congenital heart disease. The presence of such a diphasic QRS is confirmatory of this diagnosis, and, when the two phases are large and of equal extent, the finding is pathognomonic.

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EXTREME CARDIAC ENLARGEMENT*

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A CAREFUL search of the literature for records of hearts weighing 1,000 gm. or more revealed that only 38 such instances were reported in the past century. This is partly to be accounted for by the fact that large hearts are often mentioned only incidentally in case reports and as such are difficult to locate in the literature. This apparent infrequency is in striking contrast to our experience at the Cook County Hospital where nine patients with such hearts were admitted since 1928. The difference in frequency and the observation of a patient on our medical service whose heart weighed 1,475 gm. prompted us to report this patient in detail and to summarize the essential features in the nine cases with extreme cardiac enlargement admitted to the Cook County Hospital in the past eight years.

The largest heart on record was removed from a middle-aged man and was mentioned by Sedgwick[1] and again by Wood.[2] The specimen was said to have weighed 5 pounds and was placed in the museum of St. George's Hospital, London. Inquiry of the curator[3] elicited the information that the specimen has been lost and no information is available about the heart or the patient. A summary of the more interesting features of the remaining thirty-seven reports in the literature is found in Table I. It will be seen that all but one of the 38 patients previously reported were males, a finding which agrees with that in our series. Twenty-two of the thirty-eight cases reported were in patients under forty years of age, while two-thirds of our patients were above that age. This discrepancy may be due in part to a greater incidence of syphilis and hypertension in our group.

Further analysis of the patients reported in the literature reveals that the most frequent predominant lesions were adhesions of the pericardium and deformity of the aortic valve. Adhesions of the pericardium were present in seventeen instances and were the sole etiological factor responsible for the enlargement in five, the remaining twelve having associated valvular changes, particularly aortic insufficiency. Pericarditis without adhesions as a single lesion was associated with enlargement of the heart in two instances and was associated with valvular disease in another. Deformity of the aortic leaflets with resulting aortic insufficiency was the most frequent valvular change and was the sole causative factor for cardiac enlargement in six instances. The largest hearts showed a combination of aortic

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TABLE I

REPORTS OF HEARTS WEIGHING 1,000 GM. OR MORE OBTAINED FROM THE LITERATURE ON CARDIAC HYPERTROPHY

AUTHOR DATE	AGE OF PATIENT	SEX	HEART WEIGHT	THICKNESS OF VENTRICLES		PATHOLOGICAL ALTERATIONS
				LEFT	RIGHT	
Stokes[4] 1869	25	M	1980	3.75 cm.		Deformed aortic valve; aortic insufficiency; pericardium thickened and cartilaginous in places; acute pericarditis.
Smith[5] 1850	28	M	1755 with sac	2.5 cm.		Pericardial adhesions; mitral valve thickened; aortic valve covered with "adventitious" deposits.
Robinson[6] 1883	39	M	1590 with sac	3.0 cm.		Pericardial thickening, no adhesions mentioned; deformed aortic valve; aortic insufficiency; mitral valve thickened; slight renal granulation.
Sedgwick[1] 1854	26	F	1507	4.4 cm.		Pericardial adhesions; mitral and aortic valves deformed; no aortic insufficiency; aorta dilated; aortic stenosis?
Bristowe[7] 1861	22	M	1395	2.1	0.4 cm.	Pericardial adhesions; thoracopericardial adhesions; deformed aortic valve; aortic insufficiency.
David[8] 1862	42	M	1395			Right pleural adhesions and effusion; pericardial effusion; intense endocarditis of both sides of heart.
White[9] 1885	middle age	M	1380	2.5 cm.		Aortic valves thick and incompetent; no vegetations; one cusp turned on itself; mitral valve insufficient but not deformed; kidneys slightly granular.
Bell[10] 1847	40	M	1350 with sac			Mitral valve slightly thickened and opaque; all chambers hypertrophied; pericardium healthy.
King[11] 1845	29	M	1335			Pericardial adhesions; deformed aortic and mitral valves; aortic insufficiency and stenosis; aorta thinned and slightly dilated.
Cabot[12] 1926	31	M	1328			Pericardial and mediastinal adhesions; aortic valve 7 cm.; double murmur over precordium.
Metcalfe[13] 1852	24	M	1320	3.75 cm.		Pericardial adhesions; deformed aortic valve; aortic insufficiency; free edges of mitral valve thickened; fatty degeneration of myocardium and kidneys.
Cabot[12] 1926	30	M	1273			Pericardial and mediastinal adhesions; aortic orifice enlarged; acute endocarditis (aortic); deformed aortic and mitral valves; double murmur everywhere; subacute glomerulonephritis.

TABLE I—CONT'D

Gardere and Rousset[14] 1928	56	M	1270			Serous pericarditis; pulmonary tuberculosis; pleural effusion; tuberculous peritonitis.
Peacock[15] 1854	65	M	1248	3.6	0.9 cm.	Slight atheromatous degeneration of aortic and mitral valves and aorta.
Brack[16] 1931	42	M	1210			No macroscopic scars; no microscopic done.
Dulles[17] 1884	18	M	1200			Pericardial adhesions; double mitral murmur; kidneys large, congenitally lobulated.
Hodenpyl[18] 1890	21	M	1200 about			Pericardial adhesions; deformed aortic valve; aortic insufficiency (?).
Kinney[19] 1884	60	M	1200	2.5	0.6 cm.	Mitral and aortic valves insufficient; no valvular deformities mentioned; myocardium at apex thin; kidneys enlarged and lobulated; cysts of left kidney; inflammatory rheumatism when young.
Howard[20] 1892	20	M	1180			Pericardial adhesions; deformed aortic and mitral valves; aortic and mitral insufficiency; nephritis; scars of myocardium; coronaries dilated.
Cabot[12] 1926	19	M	1158 with sac			Pericardial and mediastinal adhesions; valve orifices enlarged; chronic nondeforming endocarditis, aortic; double murmur; Corrigan and pistol shot.
Cabot[12] 1926	52	M	1150			Pericardial adhesions; valve orifices enlarged; systolic at apex (loud); acute endocarditis, aortic, mitral and tricuspid.
Cabot[12] 1926	31	M	1140			Pericardial and mediastinal adhesions; valve orifices enlarged; chronic nondeforming endocarditis; double murmur; aortic second loud and ringing.
Banks[21] 1863	18	M	1140	5.0 cm.		Pericardial adhesions; aortic and mitral valve deformity; aortic and mitral insufficiency; fatty infiltration of myocardium.
Gola[22] 1847	48	M	1140	2.9 cm.		Aneurysm of aorta; no valve disease; mitral insufficiency; hypertrophy of left ventricle.
Van der Byl[23] 1857	28	M	1080	2.9 cm.		Deformed aortic valve; aortic insufficiency; mitral valve slightly thickened; kidneys partly granular.
Smith[24] 1871	37	M	1080			Deformed aortic valves; aortic stenosis and insufficiency; kidneys large and indurated.
Leuf[25] 1885	29	M	1080 with sac			Pericardial adhesions; aortic and mitral lesions; aortic and mitral stenosis and insufficiency.
Balzer[26] 1875	30	M	1070	2.0 cm.		Aortic valve deformed; aortic insufficiency.

TABLE I—CONT'D

AUTHOR DATE	AGE OF PATIENT	SEX	HEART WEIGHT	THICKNESS OF VENTRICLES LEFT	THICKNESS OF VENTRICLES RIGHT	PATHOLOGICAL ALTERATIONS
Blackford, Bryan, and Hollar[27] 1936	36	M	1070	2-3 cm.		Calcified aortic valves; mitral valve thickened and scarred but not calcified; small area of pericardial adhesions (5 cm.); systolic and diastolic murmurs at the base.
Rondier and Langenieux[28] 1928	73	M	1020			Tuberculous pericarditis; no adhesions.
Peacock[15] 1854	55	M	1020	3.25	1.6 cm.	Aortic valve deformed; aortic insufficiency.
Wallace[29] 1880	21	M	1020	2.1 cm.		Deformed mitral valve; admits one finger; deformed aortic valve with vegetations some of which were calcified; vegetations extend for 1 inch on anterior ventricular wall.
Grant[30] 1933	49	M	1020 with aorta			Syphilitic aortitis; aortic insufficiency.
Willius and Smith[31] 1934	40	M	1017			Deformed aortic valve; aortic stenosis.
Roussy[32] 1903		M	1010	2.5 cm.		Aortic and mitral insufficiency and stenosis; aorta moderately dilated.
Cabot[12] 1926	19	M	1000			Pericardial and mediastinal adhesions; aortic stenosis.
Cabot[12] 1926	50	M	1000			Syphilitic aortitis; aortic regurgitation; aneurysm.

insufficiency and pericardial adhesions. Five specimens were either inadequately described or were associated with insufficient change to account for the extreme enlargement.

The nine cases constituting our series, summarized in Table II, differed in some respects from those reported in the literature. There was only one instance of pericardial adhesions. Aortic valve deformity with insufficiency was present in six instances, in one of which a mitral valve defect coexisted, and in four arteriosclerosis was also present. Nephrosclerosis with hypertension but without pericardial adhesions or valvular deformity was present in two patients. The associated lesions in our series thus differed in several respects from those described in the literature. This may be due to the older age of our patients, to the greater incidence of syphilis and hypertension, and to the more frequent recognition of syphilitic lesions as compared with observations made in the nineteenth and very early part of the twentieth centuries. Routine blood pressure observation has been the rule for the past twenty-five years but was hardly practiced before that time. A further factor in the difference between the two

TABLE II

SPECIMENS OBTAINED AT COOK COUNTY HOSPITAL

CASE	AGE	SEX	RACE	HEART WT.	BODY WT. (KG.)	HEIGHT	EDEMA	THICKNESS OF VENTRICLES LEFT	THICKNESS OF VENTRICLES RIGHT	BLOOD PRESSURE	PATHOLOGICAL ALTERATIONS
1	33	M	C	1475	88	182	++	2.5	1.0 cm.	170/55	Slight fibroplastic deformity of aortic valve leaflets; aortic insufficiency; focal areas of myocardial fibrosis and atrophy; septic staining of all organs; renal arteriolosclerosis.
2	57	M	W	1200	200.5	175	++	2.5	0.6 cm.	230/125	Renal arteriolosclerosis; chronic emphysema; obesity; nodose goiter; left coronary: ++ hyaline, fatty and calcific plaques.
3	50	F	C	1150	45.5	161		2.1	0.4 cm.	250/160	Malignant nephrosclerosis; focal supravalvular syphilitic aortitis; light yellow fatty plaques in coronaries.
4	41	M	C	1120 with sac	86	171	++	2.5	0.9 cm.		Pericardial adhesions; syphilitic aortitis; moderate coronary sclerosis; slight atheroma of aorta and pulmonary artery; renal arteriolosclerosis.
5	46	M	W	1100	84	174	+			155/135	Syphilitic aortitis; aortic insufficiency; moderate renal arteriolosclerosis; epicardial fibrosis with calcification in some areas.
6	66	M	W	1060	130	175	++	2.6	0.8 cm.		Syphilitic aortitis, aortic insufficiency; coronary ostia stenosis; coronary and aortic sclerosis; renal arteriolosclerosis.
7	28	M	W	1050	54	170	+	2.5	1.0 cm.	160/50	Deformity of aortic and mitral valves; aortic and mitral stenosis and insufficiency; hyaline plaques in coronaries.
8	52	M	C	1020	93.5	182	++			115/85	Syphilitic aortitis; aortic insufficiency; slight coronary sclerosis.
9	43	M	C	1000	80	181	++	2.0	0.7 cm.		Syphilitic aortitis; aortic insufficiency; coronary ostia stenoses; renal arteriolosclerosis; myocardial degeneration; mitral insufficiency.

series is the fact that five of our nine patients were negroes, in whom syphilitic cardiovascular disease and hypertension are very common.

The occurrence of extreme cardiac enlargement with insufficient pathological change in the heart or other structures to account for such increase in weight has been reported by several observers including Cabot,[33] Whittle,[34] Levy and Rousselot,[35] and Brack.[16] A diagnosis of extreme idiopathic hypertrophy is probably inadequate in most instances in adults. Kugel and Stoloff[36] in their survey of congenital idiopathic hypertrophy found only seventeen "true" instances, in which few of the patients lived beyond two years of age, the oldest being nine at death. There are, nevertheless, instances in

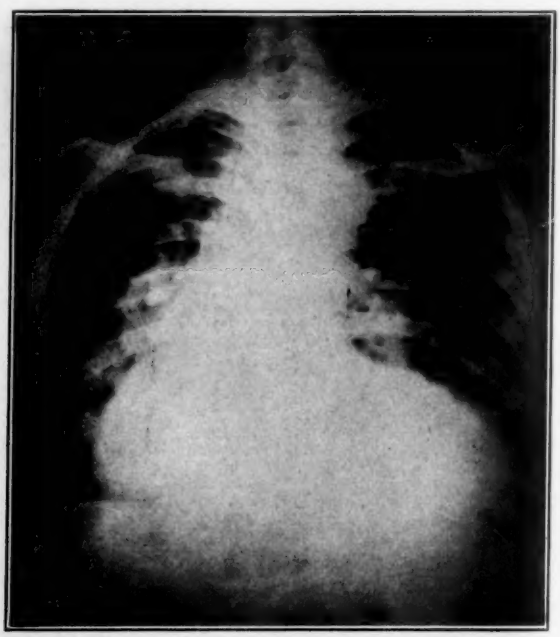

Fig. 1.—Teleoroentgenogram showing enormous boot-shaped heart, enlargement of the right auricle, widening of the aortic shadow, extension of the ventricular shadow to the left, and marked hilus congestion.

which an adequate anatomical or functional cause cannot be found with our present methods of examination, the following case report being such an example.

REPORT OF CASE

P. R., a colored laborer, thirty-three years of age, entered the Cook County Hospital Feb. 8, 1935. Three years previously he had noted "fluttering of the heart" and orthopnea for which he had been treated with digitalis until the present. His symptoms became progressively worse and were particularly severe in the three months preceding admission to the hospital.

In 1919, at eighteen years of age, the patient had a peritonsillar abscess with subsequent frequent recurrent tonsillitis until one year ago, when a tonsillectomy was performed. He had malaria in 1915, a Neisserian infection in 1922 and admitted receiving antisyphilitic treatment.

On admission the patient was dyspneic and orthopneic. The pupils were regular and equal and reacted to light. The mucous membranes were pale. Fine crepitant râles were present at both lung bases; the liver was tender and extended almost to the umbilicus; and there was edema of the lower extremities, genitals, abdominal wall, and lower back. Auricular fibrillation was noted, the ventricular rate averaging about 90 per minute. The transverse diameter of the heart was enormously increased as was the extent of dullness across the upper sternum. Systolic and diastolic thrills and corresponding rough murmurs were noted at the aortic area and over the carotid arteries. There was a diastolic murmur at the apex as well as a systolic murmur, the latter being transmitted to the axilla and back. The pulmonic second tone was accentuated.

A teleroentgenogram (Fig. 1) of the chest revealed an enormously enlarged boot-shaped heart. The Wassermann reaction was negative. Albumin, a few red and white blood cells, and an occasional hyaline and granular cast were present in the

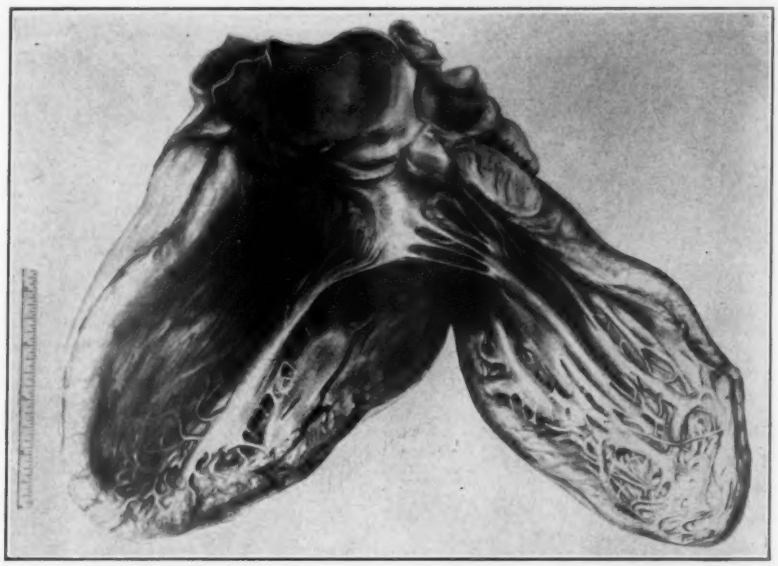

Fig. 2.—Drawing showing extreme enlargement of the heart, marked thickening of the ventricular walls, and comparatively insignificant changes of the aortic leaflets.

urine. The blood urea was 33.3 and the creatinine, 2.15 mg. per 100 c.c. A single blood pressure determination was 170/55 but was unreliable because of the existing auricular fibrillation.

The clinical diagnosis was chronic rheumatic heart disease; double mitral and aortic lesions; marked cardiac hypertrophy; auricular fibrillation; anasarca; syphilitic aortic regurgitation was considered as a possible factor.

One week after entrance the patient contracted erysipelas and died Feb. 17, 1935.

Necropsy revealed the following: The pericardial sac extended 8 cm. to the right of the midsternal line and to the left midaxillary line. The sac contained 250 c.c. of serosanguineous fluid.

The heart weighed 1,475 grams (Fig. 2). The left ventricle was 25 mm. thick and the right 10 mm. The myocardium was purple gray, very soft, and edematous. The aortic leaflets were slightly rolled. The commissures, especially between the left and middle aortic leaflets, were obliterated by firm synechiae. The endocardium of the

left ventricle was deep purple red, mottled with purple gray. The trabeculae were flattened. The aortic ring was 99 mm. in circumference. The intima of the aorta was discolored cherry red and studded with isolated hyaline plaques in the ascending portion. The intima of the descendens was smooth and stained deep cherry red. The circumference of the pulmonic ring was 100 mm. The intima of the pulmonary artery was smooth and stained red. Both coronary arteries were thin walled and their intimae smooth.

The kidneys weighed 525 gm. Their capsules stripped with ease leaving a smooth purple red surface. The sectioned cortex averaged 7 mm. The architectural markings were indistinct. At the upper pole of the right kidney the renal vein was occluded by an adherent thrombus. The thyroid showed no abnormal changes.

The microscopic report by Dr. Richard H. Jaffe is as follows:

"The fibers of the myocardium (Fig. 3) are considerably increased in thickness. The longitudinal striation is very prominent, but the cross-striation is often obscured. The nuclei are of irregular shape and rich in chromatin with a small amount of golden yellow pigment about the poles of the nuclei. The muscle fibers are atrophic

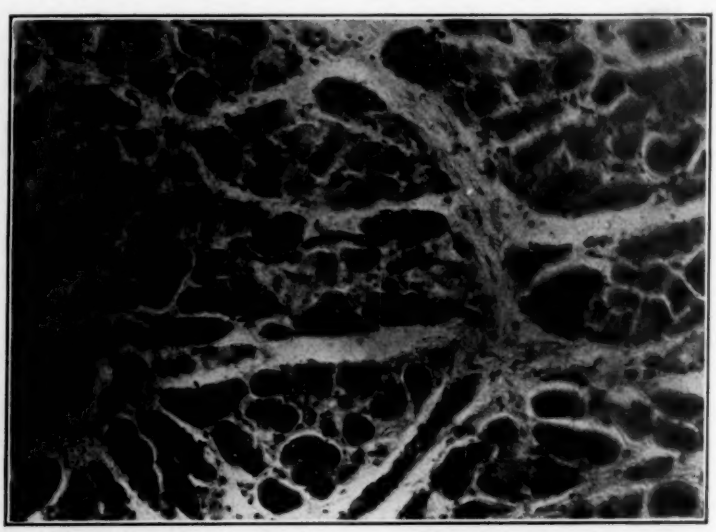

Fig. 3.—Photomicrograph (×90) of the myocardium of heart weighing 1,475 gm., showing the hypertrophy of the muscle fibers, small focal areas of muscle atrophy, and increase in interstitial connective tissue.

in small focal areas, but the interstitial tissue is increased, dense and scarlike. Outside of these areas the muscle fibers are separated by a scanty and moderately cellular stroma. The connective tissue septums about the larger vessels are thickened and contain recent extravasations of blood. The arteries and arterioles do not show any abnormal findings. The endocardium is slightly thickened. Special stains to demonstrate glycogen in the myocardium failed to reveal abnormal deposits of this substance.

"The glomeruli of the kidney are of moderate cellularity and the capsular space is empty. The epithelium of the convoluted tubules shows marked autolytic disintegration. There is a moderate thickening of the walls of the afferent and interlobular arterioles and insignificant thickening of the intimae of the arciform and interlobar arteries."

Anatomical Diagnosis.—Erysipelas; very marked hypertrophy and dilatation of the heart; septic staining of all the organs especially of the aortic intima; slight fibroplastic deformity of the aortic leaflets with insufficiency of the valve; chronic passive

congestion of the lungs, liver, and kidneys; anemic infarct of the spleen; thrombosis of a branch of the right renal vein to the upper pole; chronic hyperplasia of the spleen; chronic cholecystitis and cholelithiasis; slight hydropericardium.

DISCUSSION

The striking frequency of adhesions of the pericardium in the patients previously reported and the equally striking infrequency of this finding in our series of very large hearts is another example of how misleading such statistics based on relatively few cases can be. Rheumatic infection was more common in the younger patients who form such a large proportion of the cases of very large hearts previously reported. Our series consisted of proportionally more colored patients and persons more than forty years old. There was, therefore, a greater incidence of syphilitic aortic valve involvement and hypertensive phenomena, but this does not explain the comparative infrequency of pericardial adhesions in our series. Close study of the anatomical descriptions, incomplete as they are in many instances in the literature, reveals that pericardial adhesions alone were present in only five instances, although such adhesions are reported in almost half of the series. A valvular defect, usually aortic insufficiency, was also present in many and was probably partly responsible for cardiac enlargement.

The pathologist, as well as the clinician, is sometimes confronted by the impossibility in given instances to explain the cause of cardiac enlargement. Hypertension, thyroid disease, or other causes *assumed* to have existed previously are merely assumptions and therefore do not really explain the changes found in the heart. Disturbances of glycogen metabolism have been associated with enlargement of several organs, including the heart, but were excluded in our first patient. It may be incorrect to state that no cause can be found for extreme cardiac enlargement in some instances, but we must admit that present methods of investigation failed to reveal a satisfactory cause for the large heart found in our patient. We are forced to report this case as idiopathic cardiac enlargement, an instance in which the pathological changes found at autopsy were far from adequate to serve as a complete explanation for the extreme size of the heart.

SUMMARY AND CONCLUSIONS

1. Although only thirty-eight reports of hearts weighing 1,000 gm. or more could be found in the literature of the past century, nine such specimens were observed in patients admitted to the Cook County Hospital in the past eight years.

2. The unreliability of statistics based on small numbers of patients is again emphasized when our group of nine hearts weighing 1,000 gm. or more is compared with the reports in the literature.

3. Only one of our nine large hearts was associated with pericardial adhesions, while almost half of those previously reported were sup-

posedly due to pericardial adhesions, either alone or in combination with valvular disease.

4. The great predominance of males in both series is striking and cannot be easily explained.

5. Aortic valve deformity, usually insufficiency, was the most frequent valvular lesion found in our patients and in those previously reported.

6. A patient whose heart weighed 1,475 grams is reported in detail, and the point is emphasized that no adequate explanation can be offered either from clinical or anatomical study of this case. The term "idiopathic" is probably appropriate in this instance as we do not know the cause, and the anatomical changes are far from adequate to explain such extreme enlargement and hypertrophy.

NOTE.—We are indebted to Ashton Miller, Esq., St. George's Hospital, London, for kindly furnishing the information concerning the large heart formerly at the museum of the hospital, and we wish to acknowledge the suggestions of Dr. L. N. Katz in the preparation of this report.

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VARIATIONS IN THE ELECTROCARDIOGRAPHIC FORM OF EXPERIMENTAL VENTRICULAR ECTOPIC BEATS INDUCED IN THE MONKEY AND DOG*

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IN RECENT years a number of reports have appeared describing the electrocardiographic results obtained by stimulating various sites on the epicardial surface of the human ventricles.[1, 2, 3] In each instance attempts were made to utilize the data to elucidate the controversial subject of electrocardiographic localization of bundle-branch block and premature ventricular contractions. It was found that in most instances the type of curve was not in accord with that anticipated on the basis of the classical concept of Lewis.[4, 5] To complicate the issue, the results were not as conclusive as might be wished since the exact location of the site of stimulation could not be determined in most cases, nor could many sites be used in any one subject. Moreover, the hearts of the subjects studied were generally not normal as to size and position, and these factors might have contributed in distorting the electrocardiographic findings (Katz and Ackerman).[6] As a result, Kountz and his associates[7, 8, 9] decided to reinvestigate the subject by producing premature ventricular contractions in after-living perfused human hearts, in perfused dogs' hearts placed in human chests and, finally, in monkeys' hearts. Unfortunately, they merely stimulated isolated points in each case grossly similar to those examined by Barker and his associates,[1] and, although their results in general confirmed those obtained by the latter workers, they did not significantly clarify the underlying factors responsible for the variations in contour and form of the electrocardiographic curves.

Recently, Abramson, and Weinstein[10] investigated the subject in cats in a more systematic fashion by applying electrical stimuli to the epicardial surface of the ventricles in a short steplike procedure at various levels. They found that the initial deflection of the records was upwardly directed in Lead I when the right ventricle was stimulated and, also, in the case of various sites on both surfaces of the left ventricle in the vicinity of its right border (i.e., near the interventricular grooves). Stimulation of the rest of the left ventricle gave

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curves in which the main initial deflection was downwardly directed. In Lead III the main initial deflection was negative when stimulating various sites on the posterior surface of both ventricles and various sites on the anterior inferior portion of the left ventricle. It was positive when stimulating the rest of the anterior surface of the heart.

In order to rule out the possibility that this might be a species peculiarity limited to the cat, it was decided to repeat the experiments in the dog's and the monkey's hearts; the latter, in many respects, being more like the human heart than that of any other experimental animal. In the experiments on the dog it was possible to obtain other information concerning the effect on the electrocardiographic contour of these ectopic beats by changing the position of the heart and, also, by altering the nature of the electrical conductors in contact with it. This last was done in order to determine whether or not such a procedure would modify the contour of the ectopic beats as it does that of normal beats (Katz and Korey[11] and Katz, Gutman, and Ocko[12]).

In this report, therefore, three lines of investigation are presented: (1) further data as to the basic factors underlying the electrocardiographic form of experimentally produced ectopic ventricular contractions in the monkey and dog; (2) the effect produced upon the contour of these ectopic beats by displacing the heart from its normal experimental position; and (3) the effect produced upon their contour by altering the normal electrical field surrounding the heart (a) by the application of shunts between certain sites on its epicardial surface and distant portions of the body and (b) by placing an insulator between the heart and the posterior muscle mass.

METHOD

The experiments were performed upon three rhesus monkeys and six dogs, the former being anesthetized by the intraperitoneal injection of dial (0.6 c.c. per kilogram of body weight), the latter by the intravenous injection of sodium barbital. This series was considered large enough since the results were generally consistent and since an almost unlimited number of points could be studied in each animal. The preliminary steps were similar to those described in a previous paper.[10] Artificial respiration was begun, and the heart was exposed by removing the sternum and adjoining portions of ribs and cartilages. The pericardium was slit and used to make a hammock for the heart. Stimuli were then applied by means of an electrode consisting of a No. 26 hypodermic needle with a fine insulated wire passing through the center. The outer tube and the inner wire were each led to the terminals of a secondary coil of an inductorium. The entire electrode was insulated except for the free edge of the needle and the tip of the wire. When the posterior wall was being stimulated, a similar type of electrode was utilized except that it had a 90° bend close to its tip; the normal position of the heart further being maintained by light pressure on its anterior surface with a gloved hand. A series of ectopic ventricular contractions for each site of study was obtained by means of the Lewis interruptor connected to an inductorium, the effective stimuli being break shocks produced at a rate slightly greater than that of the sinus pacemaker. The

standard three leads were recorded in each instance; in the dog Leads I and III were generally taken simultaneously on a single camera with a Victor and a Cambridge machine. In most of the experiments on the dog after the data were obtained with the heart in its normal position, it was then either rotated to the right or left on its long axis, or pulled to the right or left without this rotation, or its apex was elevated or depressed. These steps were carried out either with the gloved hand or with traction on ligatures inserted in the lateral walls of the ventricles. In the rotation experiments all other relationships, except those being investigated, were kept constant by continuous traction in a caudal direction with a stay suture inserted through the apex of the left ventricle.

The shunt employed in these experiments consisted of a disk of silver the size of a dime to which was soldered (with silver solder) a long piece of 18-gauge silver wire. The disk and the ends of the wire were covered with silver chloride; the rest of the wire was insulated. The free end was inserted through the muscle of various parts of the body while the disk was held lightly against a single region on the epicardial surface of the ventricles with the gloved hand. In some instances, a sheet of thin rubber dam was placed under the heart so that no portion of the posterior ventricular surface was in direct contact with the posterior muscle mass, special precautions being taken to replace the heart in its normal position.

DISCUSSION OF RESULTS

Electrocardiographic Form of Ectopic Beats With the Heart in Its Normal Experimental Position.—By means of short steplike movements of the electrode over the epicardial surface of the ventricles, a series of ectopic ventricular contractions was elicited at different transverse levels, the various portions being stimulated in the following counterclockwise sequence: anterior, lateral, and posterior surfaces of the right ventricle, the posterior aspect of the septum, the posterior, lateral, and anterior aspects of the left ventricle and, finally, the anterior aspect of the septum. Although all three leads were obtained for each site of artificial impulse formation, the presentation of data will deal only with the changes in Leads I and III, the curves of Lead II conforming to either of these but most often to those of Lead III.

In the case of Lead I, as the stimulating electrode was moved counterclockwise, beginning first on the right ventricle, the recorded complexes consisted of a main initial deflection that was positively directed. As the electrode approached the posterior interventricular groove from the right side, the amplitude of the initial wave gradually diminished until the latter became almost negligible or minutely diphasic and the negative when the electrode was moved over the left ventricle in the vicinity of the groove. Over the rest of the left ventricle, the main initial deflection remained directed downward until the anterior interventricular groove was approached. Here the amplitude began to diminish until, finally, the main initial deflection reversed its direction and again became positive. The same type of change was observed at the different transverse levels. If the sites at which stimulation produced curves in Lead I containing very low

or small diphasic initial complexes were joined, it was found that a line of transition consisting of two limbs could be mapped out, one running on the anterior surface of the ventricles from base to apex, the other on the posterior surface, with both meeting at the apex of the heart. As in the cat,[10] this line of transition in both the monkey and the dog did not conform to any anatomical boundaries between the two ventricles. It ran for the most part obliquely on the left ventricle some distance to the left of the interventricular grooves, except that in the case of the monkey's heart, the basal portion of the anterior limb tended to extend onto the right ventricle over the conus region (Fig. 1), a finding not as constant in the dog.

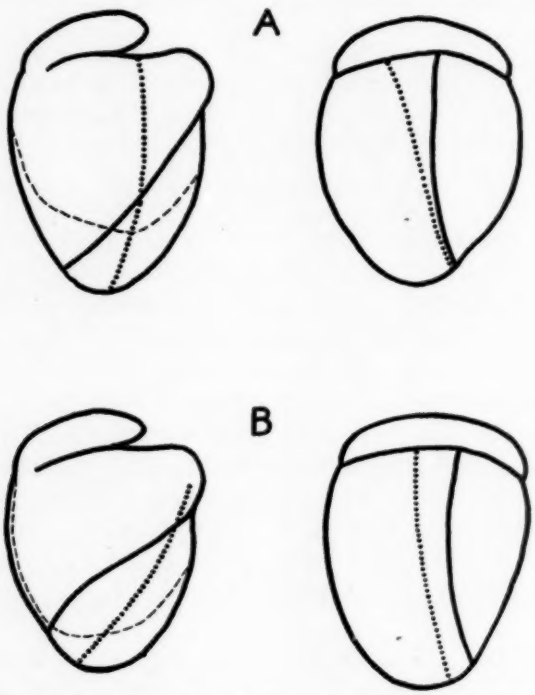

Fig. 1.—Diagrams of anterior and posterior aspects of the heart of the monkey *A*, and the dog, *B*, to show the average position of the lines of transition. The anterior aspects of the hearts are on the left and the posterior on the right. Dotted lines represent line of transition for Lead I and dash lines for Lead III. Discussed in text.

A line of transition, which followed a different course from that of Lead I, was similarly mapped out for Lead III. It was found that the direction of the main initial deflection of the curves obtained from the basal anterior surface of both the right and left ventricles was consistently positive, and only when the stimulating electrode approached the lateral borders of the ventricles did a transition occur. This transition consisted of the appearance first of a diphasic initial complex with a small negative wave and a large positive wave; then the negative phase gradually increased in size and the positive phase

simultaneously decreased. When the stimuli were applied to the posterior surface of both the right and left ventricles, the main initial complex was negatively directed. A transition also occurred at the anterior inferior border of the heart, taking place at a slightly higher level on the anterior surface of the left ventricle than on the right. The line of transition for Lead III extended downward from the base of the heart, along the lateral border of the right ventricle, continued onto the inferior edge of this ventricle and extended across the anterior surface of the left ventricle near its inferior border and then upward and somewhat posteriorly over the lateral border of the left ventricle to the base (Fig. 1).

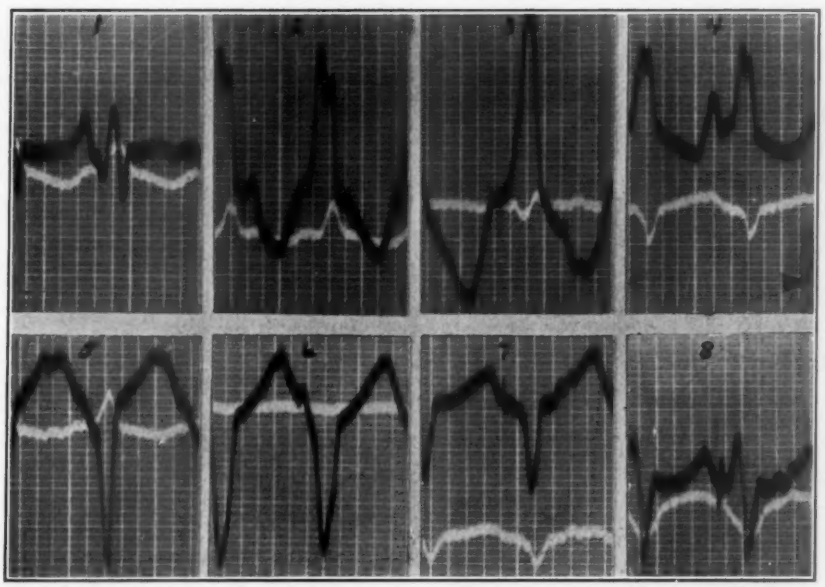

Fig. 2.—Variations in the electrocardiographic form of ectopic ventricular beats in the dog. Simultaneous tracings, with Lead I taken on the Cambridge machine (white line) and Lead III taken on the Victor machine (black line). Curve *1*, site of stimulation on lateral surface of right ventricle, in the vicinity of the line of transition for Lead III. Curve *2*, site of stimulation on anterior surface of right ventricle some distance from the lines of transition for Leads I and III. Curve *3*, anterior surface of left ventricle close to the interventricular groove and on the line of transition for Lead I. Curve *4*, anterior surface of left ventricle, some distance from interventricular sulcus. Curve *5*, posterior surface of right ventricle midway between its lateral border and posterior interventricular sulcus. Curve *6*, posterior surface of left ventricle, close to the interventricular groove and on the line of transition for Lead I. Curve *7*, posterior surface of left ventricle midway between its lateral border and posterior interventricular groove. Curve *8*, lateral surface of left ventricle on line of transition of Lead III. Discussed in text. The amount of parallax present is too small to explain the difference in the time of onset and offset of the initial and terminal deflections in Leads I and III.

In both Leads I and III the terminal ventricular deflection also manifested a transition and reversal, but in an opposite direction to that of the initial complex. The location of the lines of transition, however, was not exactly the same for both, so that from some sites curves were obtained in which the initial and terminal deflections

were in the same direction. Furthermore, the width of the initial complex in these instances was generally within normal limits or only slightly increased, and the amplitude of the wave even less than that of the normal QRS complex. In other words, the curves of ectopic ventricular beats obtained by stimulation near the line of transition of a lead did not possess any of the characteristics usually associated with such electrocardiographic records. The differences between the so-called typical and atypical type of configuration were clearly brought out when simultaneous tracings of Leads I and III were taken. Figure 2 which presents curves (Curves *3* and *6*) obtained by stimulation in the vicinity of the anterior and posterior interventricular grooves, points near the line of transition for Lead I, exemplifies the difference in the time span of the deflections in the two leads and also demonstrates that the time of onset and offset of the initial and terminal waves in both is definitely out of phase. In the light of the above, therefore, it must be stressed that the designation of one of these tracings (i.e., Lead III) as typical of a record of a premature ventricular contraction and the other (i.e., Lead I) as atypical is not justifiable, since there are numerous sites, stimulation of which will produce curves falling into the latter category.

Examination of Fig. 1 reveals that a so-called right ventricular type of curve, i.e., one with a main deflection that is positively directed in Lead I, can be obtained not only from the entire right ventricle but also from a strip of left ventricle adjacent to the interventricular grooves on both surfaces. Further, in the monkey a left ventricular type of curve could be obtained from the conus region of the right ventricle. In other words, in the case of the dog and monkey, as well as in the cat, one cannot localize with certainty the origin of a premature ventricular contraction to either ventricle merely on the basis of direction of the main initial deflection. The information derived from Lead III will help to limit the site of impulse origin to one or the other aspect of the heart, although here again the anterior inferior portion of the left ventricle is an exception, in that stimulation in this region produces a type of curve similar to that obtained from the entire posterior surface of the ventricles, i.e., one containing a negatively directed main initial deflection.

The so-called concordancy and discordancy relationship which was first emphasized by Lewis[5] and to which has been attached considerable significance by subsequent investigators[1, 9] appears in the light of the above findings to be merely a fortuitous one. In other words, the fact that the direction of the main deflection in Leads I and III is the same (concordant) or dissimilar (discordant) by itself does not add to the information which can be obtained by an examination of each lead in succession. However, since the lines of transition for Leads I and III intersect, the surface of the heart can thus be divided

into four areas. By consideration of curves obtained with both leads, therefore, an attempt at more accurate localization (i.e., to one or the other of these quadrants) can be made.

The transverse level at which the impulse enters the conduction system does not appear to influence materially the type of curve obtained, contrary to the opinion expressed by Barker and his coworkers[1] in the case of man. For example, on the posterior surface of the heart, the same type of curve is obtained in Lead III, regardless of whether the base or apex of either ventricle is stimulated, so long as precautions are taken not to apply the stimulus to the inferior or lateral borders, where the line of transition for this lead is located. The only site where a relationship to the transverse level might seem to hold is the anterior surface of the left ventricle, since an upwardly directed main initial deflection in Lead III is obtained from the base and one directed downward from the apex.

It would appear, therefore, that the type of curve obtained by stimulating the surface of the ventricles depends upon the relation of the point stimulated to the mass of ventricular muscle as a whole and not upon its relation to the two networks of Purkinje; the latter statement is not in accord with the opinions of Lewis[13] and Barker and his associates.[1]

Changes Observed in the Form of the Extrasystolic Waves With Displacement of the Heart From Its Normal Experimental Position.— Since recent experimental work[6] has emphasized the importance of the position of the heart upon the contour of the extrasystole obtained from a specific site on the ventricles, it was decided to investigate this phase of the subject further by obtaining first the line of transition for Leads I and III with the heart in its normal position and then noting the effect upon the location of these lines after displacing the heart in various directions. This was accomplished by maintaining the heart in the new position and stimulating the ventricles as before and thus determining the lines of transition anew.

When the heart was rotated on its own long axis to the right, so that more of the left ventricle presented anteriorly, the anterior limb of the new line of transition for Lead I was found to extend downward, still over the left ventricle, but to the left of the normal line, the amount of displacement varying with the degree of rotation. With the rotation of the heart in the opposite direction so that its anterior surface was composed entirely of right ventricle, the anterior limb of the line of transition for Lead I now extended downward over the right ventricle only. The location of the posterior limb of the line of transition for Lead I also varied with these procedures. With rotation to the right it extended entirely over the right ventricle, and with rotation to the left entirely over the left ventricle, the displacement being exactly opposite to that of its counterpart on the anterior

surface. Thus, the line of transition for Lead I seemed to retain its relation to the body and to the recording lead line (i.e., a line extending between the two shoulders anteriorly) within narrow limits during these rotations, although its exact position on the heart surface varied, of course, with the degree and direction of rotation. On the other hand, when the apex of the heart was moved to the right or to the left, without permitting rotation of the heart on its own long axis, or when the apex was elevated sternad or depressed vertebrad, very little change took place in the location of the line of transition for Lead I on the heart surface. Obviously then, the relation of this line to the body and to the recording line of Lead I was altered by these last procedures, contrary to what occurred when the heart was rotated on its own long axis.

In the case of Lead III, the greatest change in the site of the line of transition was also observed when the heart was rotated on its own long axis. Under these conditions the line was displaced from its location on the lateral wall of the ventricles onto their anterior or posterior surface depending upon the direction of rotation. Again the position of the line of transition altered little with respect to the body. With elevation or depression of the apex of the heart, a slight change in the location on the heart of the inferior portion of the line was noted, but none occurred when the apex was displaced to the right or left without rotation of the heart on its own long axis. In other words, with these latter procedures, the line of transition changed with respect to the body. It would, therefore, appear that only when the heart is rotated on its own long axis and not disturbed otherwise will there be no shift in the relationship of the lines of transition to the recording lead lines and to the body as a whole.

Effect Upon the Electrocardiographic Contour of Ectopic Ventricular Beats by Altering the Electrical Conductors in Contact With the Heart.—In order to determine whether altering the conditions under which the electrical currents are conducted away from the heart would in turn affect the type of curve produced by ectopic beats elicited from the ventricles, an attempt was made to introduce an artificial effective pathway to distant portions of the body by means of a shunt. Second, by placing a rubber sheet under the heart, the effect was also noted of eliminating to some degree one of the most important electrical conductors of the heart currents, the posterior muscle mass.[11]

It was found that, when a shunt was made in the dog between the anterior surface of the right ventricle and the right axilla (i.e., near the right arm electrode), practically no alteration was noticed in the curves recorded with Lead III. However, in the case of Lead I there was a definite change in the location of the line of transition. Its anterior limb, instead of running downward over the left ventricle,

retained the same direction, but tended to extend over the interventricular groove. In other words, it was displaced to the right by the procedure. In the case of a shunt between the right ventricle and the groin (i.e., near the left leg electrode) as was expected, the position of the line of transition for Lead I did not appear to be affected but that for Lead III was markedly altered. Negatively directed main initial complexes were obtained for sites on the anterior surface of the ventricles and positively directed ones for posterior sites—findings exactly opposite to that observed without the shunt.

In those instances in which a rubber sheet was placed under the heart, definite changes were also observed in the location of the lines of transition. In the case of Lead I, instead of the anterior limb running over the left ventricle for the most part, its upper portion now extended diagonally across the right ventricle while its lower part still retained its original position over the apex of the left ventricle. Stimulation over the conus region now produced curves possessing main initial deflections which were downwardly directed (a left ventricular type of curve). Changes in the records obtained with Lead III were also present under these conditions, but they were not constant.

These observations show that artificially induced changes in the manner in which the heart currents are conducted away from the heart can affect the electrocardiographic appearance of ectopic ventricular contractions in the standard leads.*

SUMMARY AND CONCLUSIONS

The basis for the electrocardiographic form of experimentally induced ectopic ventricular contractions was investigated in a series of three monkeys and six dogs by means of systematic application of stimuli to the epicardial surface of the ventricles. The results of this study corroborate the work previously reported by one of us (D. I. A.) in the cat and extend its scope. It was found that definite and distinct lines of transition could be obtained for Leads I and III which marked the sites of reversal in direction of the initial complex. The line of transition for the initial ventricular complex did not coincide exactly with that for the final deflection, but the two were close together. Neither the line of transition for Lead I nor that for Lead III conformed strictly to any anatomical boundary on the surface of the two ventricles. A type of curve was obtained in Lead I from portions of the left ventricle adjoining the interventricular grooves which resembled that obtained from the right ventricle; and in the monkey a type of curve was obtained from the conus region of the right

*Similarly, alterations in the contour of experimentally produced right bundle-branch block were obtained in the few experiments tried, when shunts were introduced.

ventricle in Lead I resembling that obtained from the left ventricle. In other words, in the dog and monkey, as in the cat, one cannot with certainty localize the site of impulse formation to one or the other ventricle merely upon the contour of the electrocardiographic record of Lead I. With regard to Lead III, the form of the record appeared to depend upon whether the anterior or posterior surface of the heart was stimulated, an exception being the anterior apical portion of the left ventricle, stimulation of which in this lead gave curves resembling those from the posterior surface. The terms "concordancy" and "discordancy," as applied to the relative direction of the main deflection of ectopic ventricular beats in Leads I and III, did not contribute any more information in localizing the site of impulse initiation than could be obtained from an analysis of each lead separately. Their usage, therefore, appears to be superfluous. Stimulation in the vicinity of a line of transition for a lead resulted in tracings which contained initial and terminal complexes that were of small amplitude, at times in the same phase and generally only slightly widened. Since these curves could be obtained from numerous sites on the epicardial surface of the ventricles, their designation as atypical records of premature ventricular contractions has no real basis.

With rotation of the heart on its own long axis, the line of transition for both Leads I and III remained practically unaltered with respect to the long axis of the body, although the actual location of the lines on the heart surface was changed depending upon the degree and direction of the displacement.

When, however, other types of change in the position of the heart were produced by shifting the apex, this constancy of the lines of transition were then found to remain practically fixed on the heart and to alter in relation to the body in proportion to the angular displacement of the heart. Besides these latter displacements of the heart, alterations in the character of the electrical conductors in contact with it affected the contour of electrocardiographic records of the ectopic ventricular contractions, and accordingly, the location of the lines of transition on the heart surface and also their location with respect to the body.

These results do not conform wholly with the generally accepted concept of localization of ectopic ventricular beats. They support the idea that besides the location of the site of origin of ectopic beats with respect to the recording lines of the standard leads and the mass of ventricular muscle as a whole, the position of various regions of the heart to the good and poor electrical conductors in contact with it plays a significant rôle in determining the electrocardiographic contour. The relation of the point of stimulation to the two networks of Purkinje appears to exert only a minor influence.

The observations here reported give a systematic perspective of the way in which the location of ectopic ventricular beats should be derived from the electrocardiographic records obtained with the indirect leads.

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DISPLACEMENT OF THE ESOPHAGUS BY CARDIAC LESIONS OTHER THAN MITRAL STENOSIS*

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THE advantage of radiological study of the left auricle in the first (or right) oblique position, with barium in the esophagus, is established by the literature which has slowly accumulated on the subject.[2, 24, 29] It is especially serviceable in the diagnosis of mitral stenosis. Yet in this clinic we have been impressed by other forms of heart disease which may cause backward displacement of the esophagus similar to that resulting from mitral stenosis but without the same significance in diagnosis. The conditions most commonly found to give rise to confusion are congenital heart disease, aortic stenosis and incompetence, hypertensive heart disease, auricular flutter and fibrillation, and heart-block. Rarely, a cardiac aneurysm has a similar effect.

These observations deal only with alterations in the barium-filled esophagus as seen in the first (right) oblique position, i.e., with the patient turned about 45° to the left with the *right* shoulder toward the screen. Occasionally rotation to 60° to 80° shows displacement better than rotation to 40° to 60°. For visualization of the esophagus citobaryum of the consistency of thin paste was used. Radioscopy was used as a preliminary in all cases and teleradiograms were then taken in the standing posture during full inspiration, though this does straighten out the esophagus and tends to diminish any curvature present.

ANATOMY

There are five important structures which may affect the contour and position of the esophagus (Figs. 1, 2). From above downward, they are the aortic arch, the pulmonary artery (with the left bronchus), the left auricle, the left ventricle, and the descending aorta, which impinges on the esophagus as the latter crosses in front of the aorta before penetrating the diaphragm. No attempt beyond certain necessary generalizations will be made to review the detailed anatomy. For this we refer the reader to the work of Parkinson and Bedford[19] and Evans,[10] and for the topographical anatomy, to Corning,[6] particularly his Figures 248, 249, 253, and 307. The right auricle, even when massive (Fig. 3), does not appear to press upon the esophagus, nor has the right ventricle any direct relation with it. The left auricle (or atrium) constitutes the major portion of the posterior aspect of the

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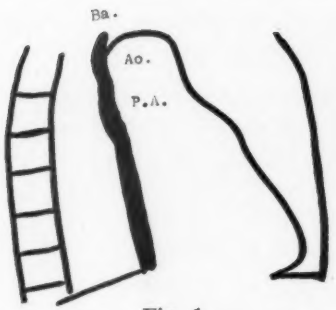

Fig. 1.

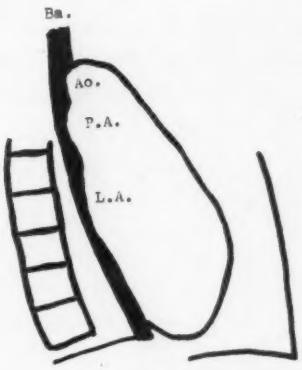

Fig. 2.

Fig. 1.—Course of normal esophagus in man, aged forty-four years, with no heart disease. Note straight descent of esophagus below pulmonary artery (left bronchus) impression.

Ao., aortic impression; *P.A.*, pulmonary artery (left bronchus) impression; *Ba.*, barium-filled esophagus.

Fig. 2.—Normal straight descent of esophagus in male, aged nineteen years, with no evidence of heart disease. A left auricular impression similar to this is occasionally seen in normal patients. There is no displacement of the esophagus.

L.A., left auricular impression. Other abbreviations same as in Fig. 1.

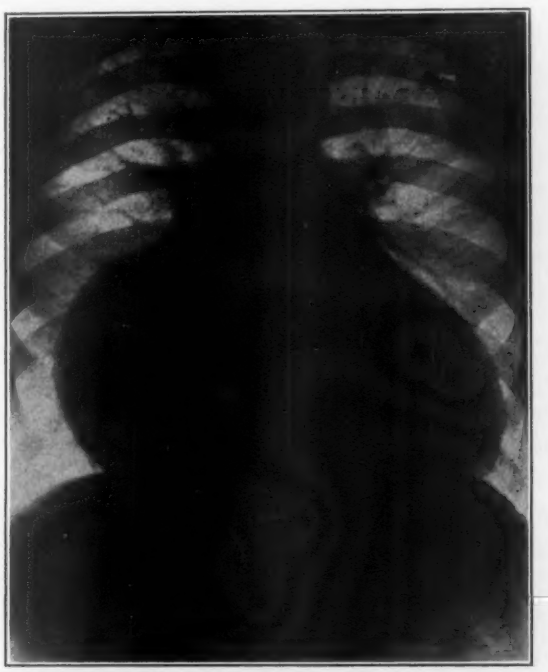

Fig. 3.—Massive right auricle in male, aged thirty-eight years. Necropsy proof. No deviation of the esophagus in first (right) oblique position.

heart, and it is to changes in its size or position or both that alterations in the esophagus are to be attributed (Fig. 4). According to Rigler,[25] the posterior portion of the left ventricle is in contact low in the thorax with the anterior wall of the esophagus over a distance of about 2-3 cm. Evans[10] feels, however, that it is rare for the left ventricle of a healthy subject to make contact with the esophagus. In heart disease associated with a large left ventricle this contact is not uncommon, as will be shown, and it produces an impression situated below that caused by a large left auricle.

CONGENITAL HEART DISEASE

Congenital heart disease, as noted by Paterson[22] and by Brown and McCarthy,[4] very infrequently affects the position of the esophagus. In our series, three cases were found presenting backward deviation of the esophagus. One patient had coarctation of the aorta, a large left ventricle and striking deviation of the esophagus (Fig. 5); the second had a patent ductus arteriosus, large heart (Fig. 6) and a slight general bend in the esophagus; the third had an interatrial septal defect. The patient with coarctation of the aorta came to necropsy and a massive left ventricle and normal left auricle were found, though the x-ray appearance suggested a large auricle. The congenital lesion which most readily deforms the esophagus like mitral stenosis is interatrial septal defect. Rösler's case[28] presented a curve in the barium-filled esophagus exactly like that of mitral stenosis, and at autopsy the left auricle was enlarged. Dr. Hoyle and Dr. Stibbe have kindly lent me records of a patient with congenital heart-block and interatrial septal defect in which the deformity of the esophagus was remarkably like that produced by mitral stenosis (Fig. 7). At necropsy the left auricle was found to be much enlarged.

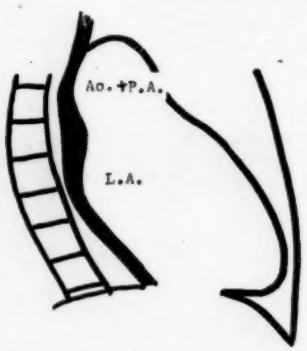

Fig. 4.—Mitral stenosis and aortic incompetence in female, aged twenty-six years. Note combined aortic and pulmonary artery (left bronchus) impression and sharp angulation caused by left auricle. Prominent conus.

AORTIC STENOSIS

Attinger[1] and Boas[3] each noted a posterior displacement of the esophagus with aortic stenosis. Care has been taken in the present series to omit any cases of aortic stenosis in which even a suspicion of

Fig. 5.

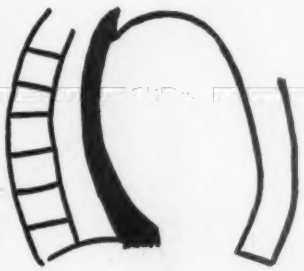

Fig. 6.

Fig. 5.—Coarctation of the aorta in female, aged forty-three years. Very large left ventricle and normal left auricle at necropsy. Striking deviation of the esophagus in the region of the left auricle.

Fig. 6.—Patent ductus arteriosus in female, aged fifteen years. No history of rheumatic fever. Continuous murmur at pulmonary area. Slight backward deviation of esophagus beginning at aortic area and extending to left auricular region. Prominent conus. Mitral stenosis with a conus this size would cause more acute and greater displacement of the esophagus.

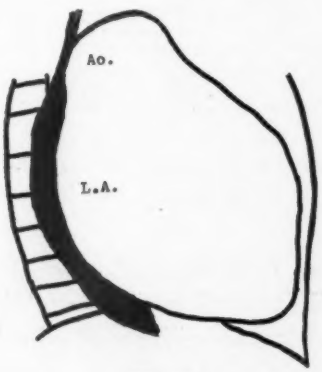

Fig. 7.

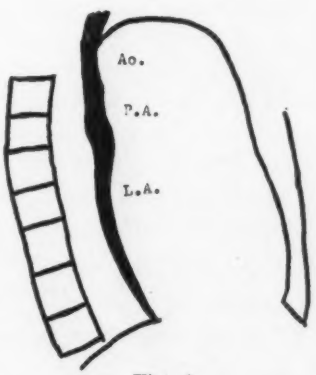

Fig. 8.

Fig. 7.—Congenital heart-block and interatrial septal defect in male, aged thirty-five years. Great size of heart, striking pulmonary conus and backward displacement of the esophagus, especially in the region of the left auricle, which was enlarged at necropsy.

Fig. 8.—Aortic stenosis, probably rheumatic, in male, aged fifty-four years. No evidence of mitral stenosis. Distinct aortic and pulmonary artery (left bronchus) impressions and moderate left auricular curve. No prominence of pulmonary conus.

mitral stenosis was entertained. In one instance of pure aortic stenosis there was slight, gentle, backward displacement of the esophagus (Fig. 8). Another similar case was seen recently. Aortic stenosis was present, and the left auricle was moderately enlarged by radioscopy. Death followed an attack of scarlet fever; at necropsy the mitral valve was normal, advanced aortic stenosis was present and the left auricle was moderately enlarged.

AORTIC INCOMPETENCE

There is an occasional reference in the literature to displacement of the esophagus by the large heart of aortic incompetence.[15, 26, 32] White[30] has described a case of pure aortic insufficiency of rheumatic origin in which the esophagus was displaced to the right on anterior view. At necropsy an enlarged left auricle was found, due, according to White, to the chronic failure of the left ventricle. Hinterreger's case[14] was

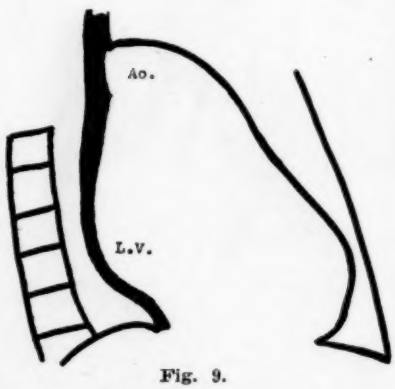

Fig. 9.

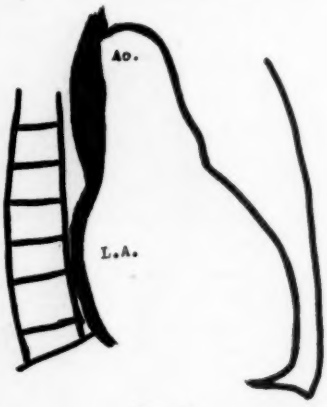

Fig. 10.

Fig. 9.—Syphilitic aortic incompetence in male, aged sixty years. Blood pressure, 170/80. Wassermann reaction, positive. Slow backward deviation of esophagus with a more sharp angulation lower down over the region of the left ventricular impression.

Fig. 10.—Aortic incompetence, probably syphilitic, in male, aged sixty-three years. Gradual backward shift of esophagus, the change occurring appreciably below the usual site of the pulmonary artery (left bronchus) curve which is not seen here.

one of syphilitic aortic insufficiency with marked stenosis of the esophagus. At necropsy there was moderate dilatation of the left auricle as well as a large left ventricle.

In this clinic we have noted several examples of backward shift of the esophagus in patients with aortic insufficiency in whom there was no fibrillation, no congestive failure, nor any evidence of mitral disease (Figs. 9 and 10).

HYPERTENSION

Kovăcs and Stoerk,[15] Brown and Reinecke,[5] and others recognized that some abnormality in the course of the esophagus might be seen in advanced hypertension, but pointed out its slight character com-

pared with the great size of the heart. Evans[10] states (p. 21) that "in the healthy subject it is rare for the left ventricle to make contact with the esophagus because the ventricle is situated to the left and anteriorly. Occasionally, however, the impression may be visible as a long shallow curve with its concavity to the right when viewed in the left oblique position. When enlargement of the left ventricle is present, the esophagus is influenced in two ways: it may be deviated by direct pressure of the left ventricle or indirectly through the left auricle." [The impression] "is more prominent in the right oblique position, and here some difficulty might arise in distinguishing the curve from the left auricular impression. Its low position with absence of abruptness in its upper segment helps in the differential diagnosis." We agree that the low position helps in diagnosis but have been impressed by occasional cases in which the displacement of the esophagus begins high up and may be quite sharp and long (Figs. 11 and 12).

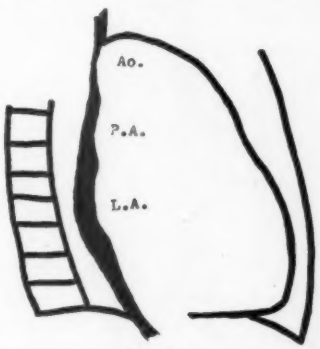

Fig. 11.

Fig. 12.

Fig. 11.—Chronic nephritis, hypertension in male, aged fifty-seven years. Very large heart. Blood pressure 250/150. Blood urea, 207 per cent. Abrupt bulge in region of left auricle but not as striking as would be expected with mitral stenosis and a heart as large as this.

Fig. 12.—Hypertension, angina pectoris in female, aged sixty-four years. Blood pressure, 200/130. No congestive failure or fibrillation. Short, sharp bulge over the left auricle. Heart grossly enlarged, displacement of esophagus moderate.

AURICULAR FIBRILLATION

Clinically the current view is that there is an increase in size of the auricles in pure auricular fibrillation. But it is difficult to find pathological proof, and to find radiographic evidence has been, except for one record,[18] even more difficult. Frothingham[11] found some evidence of enlargement of the left auricle in fibrillation in his postmortem studies. Brown and McCarthy[4] listed all the lesions of the heart or great vessels which may alter the shape or position of the esophagus, but did not mention auricular fibrillation.

We have records of one patient with enlargement of the left auricle from chronic fibrillation (Fig. 13) and another case showing an enlarged left auricle after three years of persistent flutter (Fig. 14).

THYROTOXICOSIS

Uncomplicated thyrotoxicosis may, if severe and of long standing, modify the shape of the heart and cause slight enlargement, especially in the area of the pulmonary conus, so that in the anterior view the heart may resemble that of mitral stenosis. However, the left auricle in the first oblique position is not enlarged,[17, 20] though Meyer-Borstel[16] reported a regular increase in its size which made it difficult or impossible to exclude mitral stenosis. It is in the group of cases designated thyrotoxic hypertension by Parkinson and Hoyle[21] that alterations in

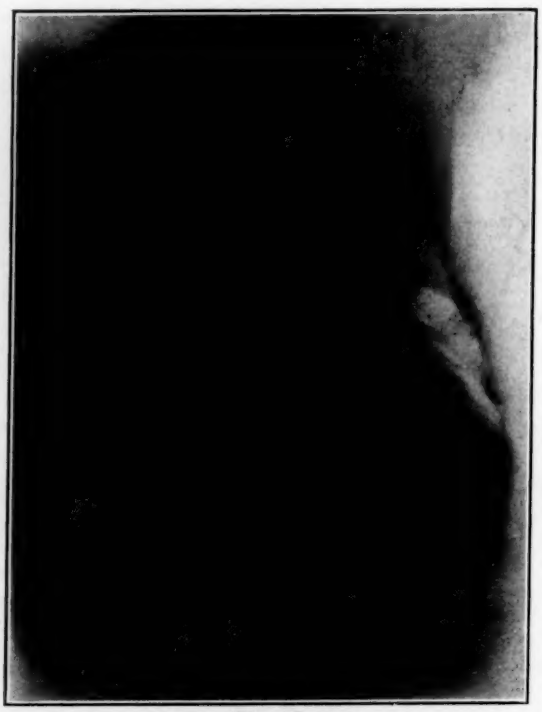

Fig. 13.

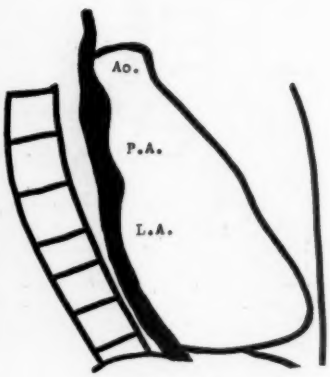

Fig. 14.

Fig. 13.—Auricular fibrillation for nine years in male, aged sixty-two years. Displacement of esophagus over region of left auricle. Very little change in early films.

Fig. 14.—Auricular flutter for three years in male, aged seventy-two years. Normal rhythm for ten months. Prominent left auricular bulge beginning sharply below the pulmonary artery (left bronchus) curve. Heart not much enlarged.

position of the barium-filled esophagus may occur. If, in addition to a large left ventricle, fibrillation or failure, or both, are present, the displacement of the esophagus may be very striking and somewhat suggestive of mitral stenosis (Fig. 15).

It is important in thyrotoxic hypertension to exclude the presence of mitral stenosis. On physical examination this may occasionally be difficult, for both hypertension and thyrotoxicosis may cause deceptive signs at the apex. It is in such cases that a study of the barium-filled

esophagus may be of assistance, for, though the thyrotoxic heart may cause slight general deformity of the esophagus, it is usually neither so high nor so abrupt as in mitral stenosis, or when high, is slight compared with the size of the heart.

COMPLETE HEART-BLOCK

Two factors contribute to the occasional displacement backward of the esophagus in complete heart-block. One is the increase in size of the left ventricle caused by the greater volume of blood which is discharged during systole;[12, 13] the other is an increase in size of the left auricle itself which Peel[23] explained in his case (with no oblique films) by stating that the auricles were frequently contracting together with the ventricles and were being ballooned out. That an increase in size of the left auricle can occur periodically with systole of the heart was shown by Dressler and Rösler.[7] Ellis' study[9] of forty-three patients with complete heart-block indicated that the heart is usually enlarged,

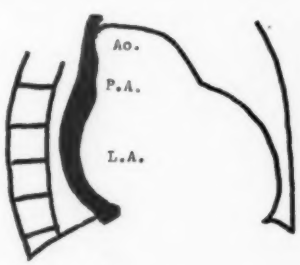

Fig. 15.

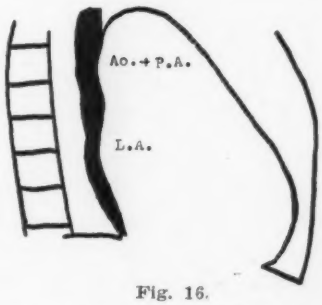

Fig. 16.

Fig. 15.—Hypertension (blood pressure, 215/110), auricular fibrillation, and moderate congestive failure. Palpable goiter. Heart greatly enlarged. Prominent backward bulge over region of left auricle, gross enlargement of heart, high diaphragm.

Fig. 16.—Complete heart-block in male, aged forty-three years. Adams-Stokes attacks for two years. No murmurs. Heart very much enlarged to right and left. Slight prominence of the left auricular curve.

as only seven had normal-sized hearts. Some of the cases of complete heart-block I have seen showed a backward deviation of the esophagus though not very abrupt or proportional to the great size of the heart (Fig. 16). One patient, with complete heart-block for at least seven years, showed no displacement of the esophagus. The heart, however, was only moderately enlarged.

ANEURYSM OF THE HEART

There are two ways in which an aneurysm of the heart, following coronary thrombosis, may deform the esophagus. In a report by East,[8] in his Case II, an aneurysm of the anterior portion of the left ventricle was pressing against the anterior chest and causing the posterior part of the heart to move farther backward. Though no barium study was done, it appears probable that the esophagus would have been dis-

placed. Bedford (personal communication) had a similar case in which barium studies showed a marked displacement of the esophagus, as in mitral stenosis. An aneurysm of the heart may also affect the esophagus directly as in the case reported by Wolferth and Wood.[31] In their patient radioscopic study showed "slight obstruction to the passage of barium in the lower end of esophagus," which was ascribed to pressure of an extremely enlarged heart. At autopsy "a large aneurysm protruded from the posterior surface of the left ventricle."

COMMENT

The explanation of the changes in esophageal contour and position herein described rests partly on increase in size of the left ventricle, partly on increase in size of the left auricle, and partly on displacement backward of a normal or hypertrophied left auricle. Occasionally, as in one case of aortic insufficiency, the large left ventricle alone causes a depression low down in the course of the esophagus which is not difficult to interpret. Occasionally, as in hypertension, the left auricle, taking part in the general cardiac enlargement, causes an abnormal impression on the esophagus. If, as not infrequently happens, the left ventricle is very large, it displaces backward this hypertrophied left auricle to cause either a more prominent depression over the area of the left auricle or a more diffuse displacement over the region of the left auricle and left ventricle. If fibrillation of the auricles or pulmonary congestion is present, these are other factors making for greater prominence of the left auricular impression. We may expect low indentation, a middle indentation or a diffuse, slow, general curve, depending on how many factors are playing a part. The low curve is easy and the general curve usually not difficult to distinguish, for it is not abrupt or sharp in its origin as in mitral stenosis. The middle curve, where the pulmonary veins and left auricle play the chief parts, is most difficult and frequently quite impossible to distinguish, for the deviation of the esophagus may be exactly as in mitral stenosis. Particular attention must then be paid to absence of a prominent pulmonary conus and absence of the square-shaped heart so common in mitral stenosis. All available evidence must be properly appraised before a diagnosis is made.

In the nonvalvular, nonhypertensive cases with backward displacement of the esophagus other phenomena explain the curve. Fibrillation and flutter place a special strain on the auricles, which may dilate and produce a bulge in the esophagus. Interatrial defect may mechanically do the same thing and the picture closely simulate mitral stenosis. In heart-block general increase in heart size, with ballooning of the left auricle, explains the backward deviation. Aneurysm of the heart produces its effect directly, when it is due to a posterior infarction, or indirectly when it is an anterior infarction.

In these various conditions one must keep in mind the sharp, high, acute bulge seen in mitral stenosis, the prominent pulmonary conus, and the square-shaped heart. Attention to these special features will eliminate many difficulties. In the remainder all evidence must be consulted before accurate diagnosis is possible.

I wish to acknowledge gratefully the abundant aid and encouragement given me throughout this investigation by Dr. John Parkinson. I am thankful, as well, for the generous help of Dr. W. A. R. Thomson, Chief Assistant in the Cardiac Department.

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Addendum

In the case report entitled "A Case of Pulmonary Embolism Simulating Coronary Thrombosis in a Young Man Aged Thirty-Three Years," published in the December, 1936, issue (Vol. 12, p. 748), the authors, Dr. Hazard and Dr. Palmer, report that the alterations in Lead IV, of Segments B and C in Fig. 1, suggested as being due to faulty placing of the electrodes, are clearly due to reversal of the electrodes. This obvious interpretation has been suggested by Dr. Louis N. Katz.

Department of Reviews and Abstracts

Selected Abstracts

Liddell, E. G., and Carleton, H. M.: Dietary and Emotional Factors Affecting the Blood Pressure of Cats, Observed by Exteriorization of the Carotid Artery. Quart. J. Exper. Physiol. **26**: 155, 1936.

Cats are naturally better subjects for experiments on the physiological effects of meat and liver than rabbits because they retain such food much better and are able to store protein rapidly in their muscles. An operative procedure is described for exteriorizing the carotid artery of cats. The effect on the blood pressure of feeding cats raw meat has been studied in some animals for as long as twenty months. During the time of observation there was no permanent rise in blood pressure after a raw meat diet. The effect of emotion and hunger on the blood pressure was much more marked than the effect from a raw meat diet.

E. A. H.

Hoff, E. C., and Green, H. D. Cardiovascular Reactions Induced by Electrical Stimulation of the Cerebral Cortex. Am. J. Physiol. **117**: 411, 1936.

The blood pressure and heart rate were recorded by mercurial and optical manometers during the stimulation of the cerebral cortex of forty cats, eighteen monkeys, and one chimpanzee under light ether anesthesia. The data obtained indicate that there is a cortical mechanism which can influence the state of the cardiovascular system and that the organism may bring this into play to make adjustments in the activity of the heart and circulation. That these responses are initiated by stimulation of nerve elements in the cortex is indicated by the fact that pressor and depressor points were localized within 3 or 4 mm. of each other; local anesthesia abolishes the responses. Undercutting of the stimulated area eliminates responses from this area and removal of the overlying cortex with subsequent degeneration of the underlying efferent fiber tracts prevented vasomotor responses from stimulation of these tracts. The effects can be elicited in noncurarized animals and epileptiform changes of muscular response are observed to occur without changes in blood pressure.

E. A. H.

Udvardy, L.: Changes in Form and Size of the Heart in Pulmonary Disease—Pulmonary Sclerosis. Fortschr. a. d. geb. d. Röntgenstrahlen **52**: 115, 1935.

Bronchial asthma and chronic pneumonia, by destroying alveoli, increase pulmonary arterial pressure and cause hypertrophy and dilatation of the right heart. In emphysema the heart at first looks smaller because of the inspiratory position of the diaphragm. Later the right heart becomes enlarged, and then both sides of the heart are enlarged to give a picture resembling the heart in mitral disease.

Pulmonary sclerosis occurs often in emphysema. Pulmonary sclerosis may be primary or secondary. The heart appears bullet shaped, and the pulmonary bow

is very prominent and may appear aneurysmal. Six cases of pulmonary sclerosis are presented, four proved by autopsy. In one of these there was endarteritis obliterans.

Cor pulmonale must be distinguished from congenital heart, mitral heart, and tumors of the mediastinum.

L. N. K.

Urban, H.: The Carotid Sinus Reflex in Man. Deutsche Med. Wchnschr. **61**: 1597, 1935.

Stimulation of the sinus nerve surgically exposed in man had no effect on epilepsy but caused a marked fall in the blood pressure. After a delay of a few seconds, changes in the pulse were inconstant, but usually a tachycardia developed which outlasted stimulation for a minute. Extirpation of the sinus nerves caused a rise in the blood pressure lasting at most an hour or two. Similar blood pressure elevation was caused by pressure on the common carotid and also followed novocainization of the sinus nerves. A respiratory standstill of a few minutes' duration occurred an hour after the operation, and this was stopped by carbon dioxide inhalation. These observations confirm studies on animals.

L. N. K.

Ulrich, B.: The Action of Carbaminocholinchloride (Doryl, Merck) Upon the Circulatory and Gastrointestinal Systems. Klin. Wchnschr. **15**: 1445, 1936.

Doryl was given to twenty-seven patients with anacidity or low gastric acidity and to eleven patients with hypertension by subcutaneous injections of from 0.25 to 0.50 mg. in an attempt to evaluate the proportionate muscarine-like and nicotine-like action of the drug. In patients with anacidity it had little if any effect, but, if the acidity was low, its effect was quicker and at least as great as histamine.

Of the patients with hypertension four had arteriosclerosis, and in these patients little change in blood pressure was noted. In the others a fall in pressure was observed in all cases (the only example given shows a drop from 155/115 to 135/90 mm. Hg). Although the P-R interval of the electrocardiogram was generally slightly increased, and in a few cases ventricular extrasystoles occurred, the author believes that the effect on blood pressure was entirely peripheral because the pulse pressure remained constant. This seems a doubtful conclusion since, when pressure falls, a greater systolic output is required to maintain the same blood pressure. The author concludes that the chief action of doryl is muscarine-like, i.e., stimulation of the parasympathetics.

J. M. S.

Thomas, Henry M., Jr.: The Effect of Ventricular Asystole on Respiration. Bull. Johns Hopkins Hosp. **59**: 213, 1936.

Records are presented showing the respiratory irregularities which occur in a patient with ventricular asystole. These records reveal close similarity to those which have been produced in laboratory animals by lowering and raising arterial pressure in the carotid sinus or by sudden obstruction and release of cerebral blood flow. One or both of these mechanisms seems to be responsible for the changes in respiration produced by asystole. Alterations in the oxygen or carbon dioxide tension of the arterial blood or in its hydrogen ion concentration do not afford an explanation of the changes in respiration caused by asystole.

Carotid sinus respiratory reflexes produced by changes in arterial pressure have not previously been pointed out in human beings. This recently discovered mechanism must be considered as an active factor in governing the respiration of man.

AUTHOR.

Nathanson, M. H.: Pathology and Pharmacology of Cardiac Syncope and Sudden Death. Arch. Int. Med. **58**: 685, 1936.

Structural changes in the heart are usually inadequate to explain either temporary or fatal cardiac syncope.

There are two physiological mechanisms in the heart which may cause sudden cessation of the circulation: (1) cardiac standstill and (2) ventricular fibrillation. In the present study it was possible to manipulate the human cardiac mechanism (1) mechanically, producing cardiac standstill by reflex vagus stimulation, and (2) chemically, inducing a prefibrillation state in the ventricles by sympathetic stimulation with epinephrine administered intravenously. It has been demonstrated that both of these physiological states may be definitely modified by drugs.

Drugs of the epinephrine series in proper dosage will prevent cardiac standstill.

Prefibrillation rhythm may be prevented by the use of quinidine or of acetyl-beta-methylcholine.

Protection of the sympathetic nervous mechanism by general measures is indicated.

These studies suggest an approach by drug therapy and by general measures toward the prevention of cardiac syncope and sudden death.

AUTHOR.

Steinberg, Bernhard, and Mundy, Carll S.: Experimental Pulmonary Embolism and Infarction. Arch. Path. **22**: 529, 1936.

The introduction of a large number of emboli into the pulmonary arterial tree of a dog is not followed by any untoward symptoms nor is it incompatible with life, at least over one and one-half years, the maximum period of observation in these experiments. As much as 79 per cent of the dog's total lung by weight can be deprived of its pulmonary arterial circulation without causing death of the animal. The obstruction produced in these experiments was not of the main pulmonary trunk (as with other investigators) but of the branching tree of the arteries. As far as the dog is concerned, under the conditions of our experiments there is no justification for the concept that multiple emboli as such cause either immediate or delayed death by their presence in the lung or by a reflex.

Iodized oil injected into the pulmonary arteries of a living animal outlines the arterial tree and determines the areas of the lung to which the circulation is shut off. Apparently, because of the extensive vascularity of the lungs, emboli do not close the blood supply unless they are introduced in fairly large numbers. A small number of emboli may, however, interfere in part with the circulation to a given area of the lung. The mere introduction of foreign bodies into the pulmonary arteries should not lead to the assumption that an infarct must develop at the site of embolism.

The lung tissue deprived of its pulmonary blood supply shows some restoration after a period of three or more weeks. The pulmonary arteries in the areas of infarction become visualized on injection of iodized oil, and canalization and newly branching arteries become more profuse with time.

The bronchial circulation may be outlined by injection of iodized oil in a living animal. In a normal dog the bronchial arteries are very indistinctly outlined. In infarcted areas the bronchial vessels are well visualized, denoting dilatation. It is assumed that the dilated bronchial circulation is responsible for the failure of infarcts of the lung to proceed to complete necrosis and scar formation. The bronchial arteries dilate irrespective of the size, location, or multiplicity of infarcted areas.

Grossly and microscopically all the criteria of hemorrhagic infarcts are present in the lungs of dogs with sufficient emboli to produce complete obstruction of the

blood supply. No other factor except emboli is necessary for the production of infarcts. Partial interference with the pulmonary blood supply results in certain morbid changes consistent with the degree of obstruction.

AUTHOR.

Bay, Emmet B.: The Work of the Left Ventricle in Aortic Insufficiency. J. Clin. Investigation **15**: 643, 1936.

Increasing amounts of fluid regurgitate into the "left ventricle" of a schema of the circulation in the presence of increasingly large "aortic insufficiencies."

A formula for the calculation of these amounts has been constructed using peripheral findings measurable in man, assumptions which seem valid and are compatible with known physical laws.

The formula gives comparable results to the leaks measured in the schema when elasticity, stroke volumes, and mean pressures are proportionate fractions of their values in animals and man.

The formula applied to hypothetical human aortic insufficiencies of various sizes gives approximations of the amounts of regurgitation which vary from 15 c.c. to 87 c.c. per beat with an assumed net stroke volume of 50 c.c. and a rate of 70 per minute. A discussion of the accuracy of the approximations and the factors affecting it reveals no important large source of error.

The work of the left ventricle in these hypothetical cases is calculated from the gross stroke and mean systolic arterial pressure, omitting the probably important velocity factor, and still amounting to 135 to 358 per cent of basal work with intact valves.

AUTHOR.

Weber, A.: Development of Physical Methods of Investigating the Heart. Deutsche med. Wchnschr. **61**: 511, 1935.

A brief historical picture of the "laboratory" methods of studying the heart is presented. The author emphasizes the practical value of these methods of diagnosing and treating hypertension, cardiac infarction and coronary insufficiency.

L. N. K.

Weber, A.: The Value of Graphic Methods in Circulatory Diagnosis. Deutsche med. Wchnschr. **61**: 1600, 1935.

An abbreviated, simple summary is presented showing the value of the electrocardiogram, venous pulse, and heart sound registration in the diagnosis of cardiac disorders.

L. N. K.

Knoll, W., Gironés, L., and Goerke, W.: Time Relations Between Heart Action and Electrocardiogram. Deutsche med. Wchnschr. **62**: 140, 1936.

Snychronized electrocardiographic records with cinematographs of exposed animal hearts are presented. The heart size is at a maximum when QRS is recorded. A decrease in the heart size occurs after the QRS is registered. The minimum size is reached after T is registered. A polemical discussion of the significance of electrical deflections is included.

L. N. K.

Kayser, G., and Weber, A.: Registration and Reproduction of Heart Sounds by Means of "Phototones." München. med. Wchnschr. **26**: 1032, 1936.

A method is described of recording heart sounds simultaneously with the electrocardiogram on moving cinematographic film. Sound is reproduced by a

photoelectric cell and a moving picture is projected. This method is useful for teaching since the student synchronizes auditory and visual images and can thus correlate the sounds with the electrocardiogram.

L. N. K.

Sikl, H.: Eosinophilic Myocarditis—An Idiosyncratic Allergic Disease. Frankfurt. Ztschr. f. Path. **49**: 283, 1936.

This is a case report of a thirty-six-year-old woman in whom a severe dermatitis developed following the use of bismuth and neosalvarsan in treating a possible case of syphilis. At autopsy a diffuse myocarditis was found with an unusually marked eosinophilic infiltration. Necrosis, tuberculoid nodules, and numerous myogenic "Riesen" cells were found. A second similar case of a twenty-two-year-old man with primary syphilis is also reported. No tubercle bacilli or spirochetes could be demonstrated. The author believes that this condition is not a flare-up of syphilis but an idiosyncrasy to salvarsan in the nature of an allergic reaction. The literature is thoroughly reviewed.

L. N. K.

Sohval, Arthur R., and Gross, Louis: Calcific Sclerosis of the Aortic Valve. Arch. Path. **22**: 477, 1936.

There have been described in this report the findings in eighteen hearts with so-called Monckeberg's calcific sclerosis of the aortic valve, in nineteen hearts with a grossly polyvalvular extinct rheumatic process, and in thirteen hearts with a grossly monovalvular extinct rheumatic process. Attention is drawn to the essentially different gross and microscopic features of the Monckeberg and rheumatic valvular lesions. It has been shown that the heart with the uncomplicated Monckeberg process shows practically none of the stigmas of extinct rheumatic fever and no other evidence which would indicate that the process is secondary to inflammatory changes. A discussion is given of the possible mechanisms concerned in the development of the essential Monckeberg process, from which it appears that this is purely and primarily degenerative, its occurrence and extent depending in all probability on individual predisposition to collagen involution and lipoid and calcium deposition. The findings in three hearts with submarginal aortic commissural bridging of noninflammatory nature suggest that stress and strain in the aortic valve may serve as additional factors predisposing to degenerative processes. It is suggested that in certain persons in whom there exists a predisposition toward the deposition of lipoid and calcium, inflammatory lesions with subsequent deformity of the aortic valve may impose sufficient strain on the valve to initiate the Monckeberg process.

AUTHOR.

Gross, Louis, and Friedberg, Charles K.: Nonbacterial Thrombotic Endocarditis: Classification and General Description. Arch. Int. Med. **58**: 620, 1936.

A study was made of one hundred fifty cases with autopsy in which the condition was diagnosed anatomically as indeterminate, terminal, or thrombotic endocarditis. In forty-seven cases there was microscopic evidence of fresh thrombotic vegetation, with little or no recent valvular reaction, without bacteria and without associated clinical or pathological evidence of recent rheumatic infection or of atypical verrucous endocarditis. The condition was termed "nonbacterial thrombotic endocarditis." The remaining one hundred three of the original one hundred fifty cases considered were discarded because careful histological

examination revealed bacterial endocarditis, recurrent rheumatic infection, or hyalinized fibrotic tabs due to tension and degeneration or representing healed lesions of known forms of endocarditis.

A classification of endocarditis is presented. The position of nonbacterial thrombotic endocarditis in this classification is discussed. The forty-seven cases presented in this report fall into five subdivisions. Two of these, comprising three and four cases, respectively, appeared to possess clinical and pathological features in common. In the first, the thrombotic endocarditis was associated with thrombocytopenic purpura and in one instance with widespread inflammatory involvement of serous membranes, with polyarthritis, sometimes of peculiar form, and with a variety of vascular lesions. The third group comprised thirty-two cases in which the endocarditis occurred in the course of a number of cachectic and infectious diseases, including carcinomatosis, leucemia, uremia, peritonitis, and pneumonia. The distinguishing feature of this group was the occurrence of the vegetations on valves which had invariably been deformed by preceding disease, usually by rheumatic inflammation. In a fourth, smaller, group, comprising four instances of carcinomatosis and one of uremia, vegetations were present on presumably normal valves. The fifth group comprised three cases in which the condition could not be classified.

Nonbacterial thrombotic endocarditis is viewed as an accidental occurrence in the course of any fatal disease, without appreciable clinical significance. Its development is probably dependent on previous damage to the cardiac valves. In our cases such previous damage was almost invariably due to an old rheumatic infection. While it does not seem probable that the verrucae in themselves were of direct rheumatic origin, this possibility must be borne in mind. In the first two groups of cases mentioned, the endocarditis might have been dependent also on some toxic agent which appeared to have a special predilection for endothelialized structures.

AUTHOR.

Friedberg, Charles K., Gross, and Louis: Nonbacterial Associated With Acute Thrombocytopenic Purpura. Arch. Int. Med. 58: 641, 1936.

In a previous study on indeterminate forms of endocarditis, cases of nonbacterial thrombotic endocarditis were described and classified. In certain groups there were several clinical and pathological features in common.

This report deals with one of these groups, comprising three cases, in which there were clinical features of acute fulminating (thrombocytopenic) purpura hemorrhagica.

Fever, purpura, epistaxis, bleeding of the gums, severe anemia, a low blood platelet count, poor clot retraction, a prolonged bleeding time, and a rapid downward course were the dominant features. In each case observers considered the probability of a general infection, but blood cultures were sterile.

At necropsy, in addition to nonbacterial thrombotic endocarditis, each of the three patients showed an acute splenic tumor; in two cases there was organizing pericarditis and in one case widespread vascular lesions.

The possible relationship of an infectious process producing vascular damage and the purpuric phenomena is discussed.

AUTHOR.

Friedberg, Charles K., Gross, Louis, and Wallach, Kaufman: Nonbacterial Thrombotic Endocarditis Associated With Prolonged Fever, Arthritis, Inflammation of Serous Membranes, and Widespread Vascular Lesions. Arch. Int. Med. 58: 662, 1936.

In a previous study on indeterminate forms of endocarditis, cases of nonbacterial thrombotic endocarditis were described and classified. Certain groups appeared to possess clinical and pathological features in common.

This report deals with one of these groups, comprising four cases, in which the disease was characterized by prolonged fever, polyarthritis, inflammation of serous membranes (pleura, pericardium, peritoneum, endocardium, and synovial membrane), and a variety of vascular lesions.

The clinical course was that of a general infection, but cultures of the blood were sterile. The onset was marked by inflammatory polyarthritis involving the large and small joints. Ankylosis and deformities developed in two of the four cases. There were pleural and pericardial effusions. Symptoms of endocardial involvement were indefinite. Symptoms of renal and cerebral involvement were frequent. The differential diagnosis lay between a general infection, subacute bacterial endocarditis, rheumatic fever, and tuberculosis.

At necropsy there were adhesive pleuropericarditis with obliteration of the pleural and pericardial cavities; an excessive quantity of fluid in the peritoneum; perihepatitis, and perisplenitis, with adhesions between the liver and the diaphragm, between the spleen and the diaphragm, between the intestines, and between the parietal and the visceral peritoneum. The synovial membranes, in the two cases in which these were available for examination, were thickened and edematous and showed marked endothelial hyperplasia and cellular inflammation with occasional perivascular infiltrations. The heart showed nonbacterial thrombotic deposits on one or more of the valves. There was no evidence that these were of rheumatic origin. There were a variety of vascular lesions in many organs, including endothelial proliferation, endothelial desquamation with granular degeneration and swelling, narrowing or obstruction of the lumen by plugs, intimal proliferation, and actual necrosis of the vessel wall.

The clinical and pathological features suggested that some infectious agent with a pronounced toxic effect on structures lined by endothelium was being dealt with.

AUTHOR.

Segura, A.: Registration and Interpretation of Cardiovascular Activity in the Normal Infant. Rev. argent de cardiol. **3**: 167, 1936.

The following heart rates (average and probable error) have been found according to age:

Within the first week, 150 ± 1.97; between nine and thirty days, 167 ± 3.37; from thirty-one days to three months, 154 ± 4.24; from the third month up to the sixth month, 155 ± 2.36; from the sixth month up to one year, 140 ± 2.63; from one to two years, 138 ± 6.59.

There are no significant differences between any two successive groups (except between the fourth and fifth), but there are if two separate groups are compared.

This shows that the heart rate decreases as the infants grow, and also that within the first week the rate is comparatively slower.

The phases of the cardiac cycle: According to age, the cardiac systole lasts between 0.205 ± 0.010 and 0.236 ± 0.008 sec., with a tendency to increase as the infants grow older. The following formula, modified from Lombard and Cope, allows a prediction of the duration of the systole when the heart rate is known:

$$S = 0.025 + \frac{60}{26\sqrt{R}}$$

S being the duration of the systole and R, the heart rate.

The S/C ratio is higher in infants than in adults showing a comparatively longer systole in the former. The ejection phase lasts 0.174 ± 0.004 between one and three months of age; 0.171 ± 0.0002 between six and twelve months; and 0.186 ± 0.008 between one and two years.

The isometric period cannot be accurately determined in infants. From our figures, which include the delay of the fontanellar pulse, the inference can be drawn that this phase, in absolute terms, is shorter than in adults. The ejection phase takes in infants about 48 per cent of the total cycle, whereas in adults it takes only about 34 per cent of the total cycle. The ejection phase, therefore, is relatively longer in infants than in adults.

Electrocardiogram: Our findings confirm those of previous observers. We call attention to the fact that the excitation process is slower, comparatively, in infants than in adults.

Influence of sex: No sexual differences were found throughout our study.

AUTHOR.

Coburn, Alvin F., and Kapp, E. M.: Observations on the Development of the High Blood Sedimentation Rate in Rheumatic Carditis. J. Clin. Investigation **15**: 715, 1936.

In acute rheumatism the sedimentation rate may be considered as a measure of the extent of inflammation.

The increased sedimentation rate in acute rheumatism is caused by an increase in plasma fibrinogen and globulin.

An immunological test for a qualitative difference between the plasma protein fractions of normal and rheumatic individuals gave negative results.

A possible type of mechanism is suggested to account for the rise in sedimentation rate just before the onset of a rheumatic attack.

AUTHOR.

Busch, P.: Hypertension and Menopause. Deutsche med. Wchnschr. **61**: 1680, 1935.

A brief is presented for the use of a proprietary mixture of tissue extract, ovarian hormone, and organically bound bromide in cases of menopausal hypertension based on two case reports. (This is not convincing.)

L. N. K.

Marañón, G., and Domenech, F.: Variations of Blood Pressure in Diseases of the Hypophysis. Brit. M. J. **2**: 851, 1936.

The state of the blood pressure in various hypophysary syndromes has been noted only in recent years. The facts that low blood pressure occurs in hypopituitary syndromes and that high blood pressure occurs in subjects with basophilic adenomas of the anterior lobe have been offered as bases for a conception that the anterior lobe of the hypophysis is important in the normal regulation of blood pressure. The result of a study of the blood pressure in 138 cases of hypophysary syndrome is recorded and discussed. The list does not include the cases of basophilic adenoma which have been reported in a separate paper. The data from this study indicate that changes in the internal secretions of the hypophysis do not influence the blood pressure. Such variations of blood pressure as occurred are thought to be due to normal changes which may be observed in any other group of patients. The higher pressures are found in the older patients rather than in relation to any specific state of the hypophysis. The hypertension which occurs in patients with basophilic adenomas of the hypophysis is considered to be due to hyperplastic changes in the suprarenal gland rather than to changes in the hypophyseal gland.

E. A. H.

Findlay, F. M.: Hypertension: Its Surgical Approach. California & West. Med. 45: 334, 1936.

The important factors which appear to operate in the production of hypertension are discussed. The various types of surgical procedures used for the treatment of hypertension and the probable results to be expected from each operation are described. A modification of surgical procedures is suggested, based upon the author's past experience and facts concerning the autonomic nervous system.

E. A. H.

Smith, Beverly C.: Relief of Pain by Peripheral Nerve Block in Arterial Diseases of the Lower Extremities. Ann. Surg. 104: 934, 1936.

Forty-six cases of occlusive arterial disease, including patients with arteriosclerosis with and without diabetes mellitus or with thromboangiitis obliterans, were treated by peripheral nerve block in the lower third of the leg. Pain was entirely relieved in 97 per cent of the patients with thromboangiitis obliterans, 90 per cent of the patients with arteriosclerosis without diabetes mellitus, and 81 per cent of the patients with arteriosclerosis with diabetes. In three cases the nerve block was repeated for recurrence of painful ulceration, with satisfactory relief of pain. In only three cases was healing of the wound delayed. Paralysis of the intrinsic muscles of the foot has not interfered with normal locomotion, but this weakness necessitates the subsequent use of properly fitted shoes with corrected weight-bearing. The relief of pain prevented the necessity of a major amputation in 50 per cent of the patients with arteriosclerosis and in 20 per cent of the patients with arteriosclerosis with diabetes. No amputations were performed in the group with thromboangiitis obliterans.

E. A. H.

Andrus, Frank C.: The Relation of Age and Hypertension to the Structure of the Small Arteries and Arterioles in Skeletal Muscle. Am. J. Path. 12: 635, 1936.

The degree of fibrosis of the media of small arteries and arterioles was studied in specimens of pectoral muscle taken from 137 individuals. The degree of fibrosis was most marked in cases of severe hypertension. There was a somewhat greater average amount of fibrous tissue in the walls of the arterioles in hypertensive than in nonhypertensive patients of the same age. All patients with hypertension did not show marked fibrosis. No cases of marked fibrosis were seen before the twenty-ninth year of life. After that age it was encountered with increasing frequency. It was not possible to distinguish between hypertensives and control patients by the degree of fibrosis found.

H. M.

Short, James J., Bruger, Maurice, and Jaffe, Louis: Production of Intimal Changes in the Arteries Attempted in the Rat by Prolonged Feeding of Aceto-acetic Acid. Arch. Path. 22: 543, 1936.

It appeared important to learn whether an excess of acetone bodies in the blood, as frequently occurs in diabetes, is a factor in softening the intimal cement substance, thereby favoring the imbibition and deposition of lipoids, particularly cholesterol esters. Reasoning from the results on eight rats fed aceto-acetic acid, and from six controls, ketosis is probably not a factor in altering the structure of the intima.

H. M.

Yater, Wallace M.: A Study of Four Cases of Acquired Arteriovenous Fistula by Means of Thorotrast Arteriography. Ann. Int. Med. 10: 466, 1936.

The typical findings in arteriovenous aneurysm are reviewed. X-ray demonstration of the lesion injected with thorium dioxide was made in the four cases presented. Three of the aneurysms were caused by gunshot, one by a pistol bullet. In one there was evidence that subacute bacterial arterial infection may have caused the fistula by ulceration. In two cases when the fistula was closed by compression, there was a fall in systolic blood pressure, in two a rise; in three cases a fall in pulse rate, in one a rise. In the one case in which circulation rate, by means of saccharin, was measured before and after closure of the fistula by compression, there was an increase in circulation rate.

Two patients refused operation; operation was performed on one patient with aneurysm of the popliteal artery and vein and on one with aneurysm of the femoral artery and vein. Excision of the aneurysmal sac was followed in the former case by gangrene and ascending infection, in the latter by infection in the operation site. Both of these patients died.

H. M.

Nicole, R.: Arterial Spasm in Acute Venous Thrombosis. Schweiz. med. Wchnschr. 65: 676, 1935.

This is a discussion of the diagnostic difficulties of differentiating between femoral embolism and arterial spasm. It is based on a study of six cases. The author concludes that, when doubt exists, it is best to operate since improvement occurs even when no embolus is found.

L. N. K.

Pal, J.: The Cerebral Vascular Innervation in Man. Wien. med. Wchnschr. 85: 601, 1935.

Interruption of function in certain regions of the cerebrum leads to hypotonia of the arterial wall on the contralateral side, after a delay. Damage to the cerebrum causes no hypotension as long as the medullary centers are not involved. Instead, hypertension may follow. This would indicate that there are vasomotor paths from the cerebrum to the peripheral vessels which do not require the medullary centers for their action. (The evidence for these statements is not convincing.)

L. N. K.

Collens, William S., and Wilensky, N. D.: The Treatment of Peripheral Obliterative Arterial Diseases by the Use of Intermittent Venous Occlusion: A Report of the Results in Twenty-Nine Cases. J. A. M. A. 107: 1960, 1936.

The apparatus, described in the June number of this JOURNAL, consists of a cuff, similar to a blood pressure cuff, and a pump and valve mechanism which alternately inflates and deflates the cuff. The cuff is applied to the extremity above the area to be treated. Two-minute periods of 40 to 90 mm. Hg pressure were alternated with two-minute periods of deflation. This procedure was used for as much as twelve hours a day. The 29 patients were not selected. Only those with ulcer or gangrene were put to bed. Most had not received modern therapy previously.

There was clinical improvement in many of the cases, relief of pain in most. Frank gangrene in two cases of diabetes was made definitely worse. Nearly all of the ulcers were healed. Claudication time was considerably lengthened in the 5 cases in which it was measured before and after treatment. No systematic studies of

changes in blood flow were made. In the 3 cases in which venous filling time was measured before and after treatment, there was objective evidence of increase in blood flow. In the one case reported, there was a rise in skin temperature of 4° F.

H. M.

Böger, A., and Wezler, K.: The Central Position of the Pressure-Equalizer ("Windkessel") in the Circulation. Klin. Wchnschr. **15:** 1185 and 1241, 1936.

The authors restate their conclusion, based on previous work, that the contraction of smooth muscle in the larger muscular arteries lowers the modulus of elasticity —that is to say, makes the artery more distensible. This statement is necessary for an understanding of the present problem which is concerned with changes in the effective or functional size and position of the pressure equalizer or elastic reservoir *(windkessel)* of the circulation, which includes, as has been known since the time of E. H. Weber (1850), the aorta and the first portions at least of the primary branches. A lengthy, rather involved, discussion of the theoretic considerations involved in calculating the effective *(wirksam)* length of the elastic reservoir follows. The length (L) is taken as $\frac{\lambda}{4}$ where λ is the fundamental wave length of the arterial system. λ is obtained by multiplying the velocity of transmission of the pulse along the aorta by the duration of the wave as recorded in the femoral pulse by a Frank capsule. The duration of the wave or the period of oscillation shows itself in reflected waves superimposed upon the pulse wave and is identical in length for any individual whether measured in the carotid or femoral pulse. Furthermore, the modulus of elasticity (η) = Velocity^2 multiplied by the specific gravity of the blood and the effective coefficient of elasticity of the pressure equalizer can then be considered as $\frac{\eta}{V}$ wherein V is the volume of the pressure equalized obtained as the product of the cross-section of the root of the aorta and the effective length as calculated from the equation given above.

Pulse wave tracings were obtained simultaneously from the carotid, femoral, and radial arteries followed immediately by blood pressure readings in many individuals of various ages and sizes, after the intravenous administration of adrenalin and sympathol, and in a few patients with hypertension. The pulse wave velocities, effective lengths, and coefficients of elasticity of the pressure-equalizer were calculated.

The conclusions follow:

A. The decrease in distensibility of the predominantly elastic part of the arterial system which is known to occur with increase in blood pressure and with age is compensated for by several other simultaneous changes.

1. Increase in size (length and cross-section) of the pressure-equalizer; in youths the length extends to 10 cm. above, in elderly persons to 10 cm. below Poupart's ligament.

2. Contraction of the smooth muscle in the portion included in the pressure-equalizer which increases its distensibility; this is exemplified by the small decrease in distensibility observed to follow sympathol, as compared to the large decrease following adrenalin. It is assumed that sympathol exerts a more powerful constrictor action on smooth muscle. It is this contraction which preserves the distensibility of the pressure-equalizer (aorta and large branches).

These two factors serve to make possible the small changes in blood pressure in relation to the large increase in rigidity of the peripheral arteries as age advances.

B. An abnormally high coefficient of elasticity is present in patients with hypertension.

A measure of the functional activity of the arterial elastic system is earnestly to be sought. The complexity and possibilities of error—for example, those involved in the measurement of the cross-section of the aotra, to say nothing of those arising in measuring the intervals between reflected waves in records of pulse waves—leave much to be desired. The work of these authors should serve to focus attention upon the problem.

J. M. S.

Matthes, K., and Malikiosis, X.: Studies Upon the Velocity of the Blood Stream in Human Arteries. Deutsches Arch. f. klin. Med. **179**: 500, 1936.

The principle of the method used depends upon changes in absorption of light due to changes in the oxygen saturation of blood passing through the capillaries. A beam of light is passed through a fold of skin, the capillaries of which have been previously dilated by iontophoresis with histamine, onto a photosensitive cell. The cell actuates a galvanometer, the deflections of which are recorded photographically and simultaneous with a record of respiration. The subject is made to hold the breath or to fill the lungs with nitrogen and hold the breath. The oxygen saturation of the blood falls slowly and following the first breath of either air or oxygen (no difference could be demonstrated) rises precipitously. The interval of time between the first breath and the beginning of the rise of the curve of oxygen saturation of the blood in the capillaries can then be measured. It is recognized that this interval includes the time necessary for the oxygen to pass from the mouth through the alveolar wall into the capillaries of the lungs, but this must be very small.

The optical records reproduced are numerous and beautifully clear, and the rise of oxygen saturation presents a sharp measurable deflection. The times found in noncardiac individuals from lung to ear varied from 3 to 4 seconds, from lung to finger, 8 to 16 seconds. In a varied assortment of compensated cardiac patients, the times varied from 3 to 5 seconds from lung to ear, and from 7 to 20 seconds from lung to finger. In decompensated patients the limits were for lung to ear 4 and 13.5 seconds, and for lung to finger 10 and 36.5 seconds. It is interesting that two patients with hypertension lay at the upper limit of the normal range, and one overstepped it, being responsible for the upper limit of 20 seconds from lung to finger in the compensated cardiac patients. Also two patients with hemiplegia exhibited arterial circulation times longer on the paralyzed than on the nonparalyzed side. Exercise increases the velocity.

The authors discuss the error which may be inherent in the method due to making the patient hold the breath and to various types of respiration. They appear, however, not to be cognizant of the probable error introduced by changes in mixing time and in pulmonary permeability attendant upon pulmonary congestion. The method seems, in spite of inherent errors, to be important in two respects: (1) it is not subjective; (2) combined with intravenous injection methods it affords the means of obtaining complete circulation times.

J. M. S.

Hoff, H., and Pichler, E.: Experimental Studies Concerning Regulation of the Peripheral Vessels. III. On the Question of Humeral Counter Regulation. Klin. Wchnschr. **15**: 1599, 1936.

The introduction reviews briefly two previous communications on this subject, in which it was shown that increase in the acetylcholin content of the medulla oblongata followed stimulation of the abdominal aorta but not stimulation of the

arteries of the extremities. It also followed ligation of the coronary arteries and was due, they believed, to stimulation of the periarterial nerves. The assay of acetylcholin was carried out by injection of the substance to be tested into a leech sensitized with physostigmine.

In the present study increase in the amount of acetylcholin was found to occur in the brain stem and in cisternal fluid following the same procedure. It was also shown (1) that previous injection of ergotamine prevented the increase, (2) that the increase in acetylcholin occurred following the injection of adrenalin and tetrahydrox β-naphthylamine without stimulation of the aorta, and (3) that adrenalin is also liberated in the cisternal fluid following stimulation of the aorta. Their inference is that liberation of acetylcholin is secondary to the liberation of adrenalin by the aortic stimulus as a counterregulatory mechanism.

J. M. S.

Gay, L. K., and Hardesty, J. T.: Tests for Vasomotor Control. California & West. Med. **45**: 331, 1936.

The various tests in current use for determining vasomotor control are described. Indirect methods of observation on the peripheral vessels include examination of peripheral pulse, postural color changes, blood pressure determination, cutaneous histamine reaction, the plethysmograph, and reactive hyperemia. Useful tests for direct observation of the peripheral vessels are surface temperature studies, tobacco test, overcooling, cold stimulation test, immersion of the forearms in warmed water, blanket method of Coller and Maddock, induction of artificial fever, the oscillometer, spinal anesthesia, and arteriography. The method of carrying out each test is described in detail.

E. A. H.

Moore, John W., and Kinsman, J. Murray: Studies on the Circulation: The Dye Injection Method. J. Lab. & Clin. Med. **22**: 165, 1936.

In ten cases with apparently normal cardiovascular systems, the hemodynamics was studied before, and twenty-four hours after, the oral administration of from 1 to 1.2 gm. of digitalis (digitora tablets).

By the use of the dye-injection output method, it was possible to determine simultaneously the velocity of blood flow, the flow per minute, the total circulating blood volume, the volume of circulating blood in the lungs and heart, the cell volume, and the specific gravity of the plasma. It was possible also to obtain almost at the same time, and certainly without any change in position of the patient, the venous and arterial blood pressures, the vital capacity, and the cardiac silhouette area.

In all of the factors studied, it was found that digitalis may cause an increase, a decrease, or no change at all in the individual values. The median of any group may show a decided trend; nevertheless the spread about the initial normal was prominent. This was particularly true of the venous pressure and flow per minute. In the former the median value was 60 per cent of the initial normal, whereas one patient was 150 per cent of the initial normal; in the latter, the median value was 88 per cent of the initial normal, whereas one patient was 121 per cent of the initial normal. When the venous pressure and the flow per minute are plotted against each other, there exists a fairly close linear relationship in about 70 per cent of the cases.

There was evidence of some correlation between work and cardiac silhouette area, flow per minute and cardiac silhouette area, specific gravity of the plasma and the cell volume, and total circulating blood volume and the circulating blood

volume in the lungs and heart. We believe the latter correlation is significant, in that it shows that digitalis in some cases exerts a peripheral action to cause an increase of circulating blood in the greater circulation, though not necessarily associated with changes one way or the other in the flow per minute, venous pressure, or velocity of blood flow.

AUTHOR.

Cohen, Mandel E., and Thomson, K. Jefferson: Studies on the Circulation in Pregnancy: I. The Velocity of Blood Flow and Related Aspects of the Circulation in Normal Pregnant Women. J. Clin. Investigation **15**: 607, 1936.

The arm-to-carotid, pulmonary, and venous circulation times can be studied safely in pregnancy by the cyanide method.

The values for the arm-to-carotid, pulmonary, and venous circulation times fall within the normal range of nonpregnant women.

There is a decrease in the average arm-to-carotid circulation time from the seventeenth to the thirty-sixth week of pregnancy, inclusive.

There is probably an increase in the average arm-to-carotid circulation time, relative to the seventeenth to thirty-sixth week period in the period from the thirty-seventh to the fortieth week.

There is a decrease in the average arm-to-carotid circulation time following delivery, which persists until the seventh week postpartum, after which the arm-to-carotid circulation time returns to the normal level of nonpregnant women.

There is little change in the pulmonary circulation time during pregnancy, although the trend is the same as that of the arm-to-carotid circulation time.

The speeding of the circulation in pregnancy seems to occur in the peripheral venous component of the vascular system.

Various factors that might decrease the circulation time in pregnancy are discussed, and, of them, the decreased viscosity of the blood is considered probably the most important contributing factor.

AUTHOR.

Freeman, Norman E., Shaw, John L., and Snyder, John C.: The Peripheral Blood Flow in Surgical Shock. The Reduction in Circulation Through the Hand Resulting From Pain, Fear, Cold, and Asphyxia, With Quantitative Measurements of the Volume Flow of Blood in Clinical Cases of Surgical Shock. J. Clin. Investigation **15**: 651, 1936.

Traumatic stimuli, such as cold, fear, and pain, reduced the volume flow of blood through the hand maintained at constant temperature. The decrease in blood flow which resulted from intestinal manipulation was not prevented by general anesthesia.

Asphyxia brought about an increase in blood flow in the sympathectomized hand in 5 cases. In the normal hand, the blood flow was increased in 11 cases and decreased in 6 cases. The mechanism for these reactions is discussed.

The blood flow through the hand in clinical cases of surgical shock was markedly reduced.

The low oxygen saturation of the venous blood indicated the severity of the tissue asphyxia.

The reactive hyperemia which followed occlusion of the circulation for five minutes in cases of shock was slight and of short duration.

Surgical shock is the clinical manifestation of a process which has its origin in the body's physiological reactions to various traumatic stimuli. These reactions preserve the organism through diversion of the blood supply to the vital centers. As a consequence, the outlying tissues become deprived of adequate nutrition.

Recovery from the process of shock is associated with progressive improvement in the circulation of blood to the periphery. The therapy of surgical shock should be directed toward the reestablishment of an adequate supply of oxygenated blood to the body tissues.

AUTHOR.

Esser, C.: The Kymographic Appearance of the Cardiac Apex in Marked Dilatation. Fortschr. a. d. geb. d. Röntgenstrahlen **52**: 213, 1935.

Normally, the author finds that the apex shows a larger systolic retraction than the base of the left ventricle. In pathological states, the reverse is true, and the apex in addition later actually shows systolic expansion. This latter type the author found in 27 of the 350 records of marked dilatation.

L. N. K.

Battro, A., and Menendez, E. Braun: Radiokymography in Total Auriculoventricular Block. Rev. argent de cardiol. **3**: 199, 1936.

Roentgenkymography allows a study of the volume changes of each cardiovascular segment, its application being particularly fruitful in cases of heart block.

The main radiokymographic features of the left ventricle, right auricle, median arch, vena cava, and aorta in three cases of complete A-V block are here described. They show (1) that the filing of the ventricle is definitely influenced by auricular contraction and (2) that the c-wave of the venous pulse may be partially caused by an aortic impact since the influence of the aortic pulse can be observed on the superior vena cava.

AUTHOR.

Key, Eimar: Embolectomy of the Vessels of the Extremities. Brit. J. Surg. **24**: 350, 1936.

By a modification of Carrell's method for embolectomy the author performed 48 embolectomies. The greater proportion of emboli were in the femoral, iliac, popliteal, and axial and brachial arteries. In most there was some degree of cardiac damage. Death occurred shortly after operation in five cases in spite of three's having improved circulation. Death occurred within a month in fourteen other cases in spite of four's having improved circulation. Ten cases had gangrene and lived for at least a month postoperatively. In the greater number of these cases an amputation was done. In nineteen cases the circulation was restored, the extremity saved from gangrene, and the patient lived. Twenty-four of the forty-eight embolectomies were performed within ten hours after the onset of symptoms; out of these nineteen regained normal circulation.

H. M.

Morawitz, P.: Medicinal Therapy in Undecompensated Heart Muscle Disease. Deutsche med. Wchnschr. **61**: 1, 1935.

Digitalis is useful only in heart failure. The prophylactic use of digitalis prior to operation in a healthy heart does no harm but is to be avoided in elderly subjects with coronary sclerosis. The author questions the value of Christian's suggestion that all individuals with degenerative heart disease get protracted small doses of digitalis. Digitalis therapy should be individualized. Digitalis should be used only in auricular fibrillation with a rapid ventricular rate and not when the ventricle beats slowly. It should be used cautiously for extrasystoles and in heart-block. Digitalis is not very effective in hyperthyroid states. Digitalis should be used to meet definite needs and not for heart disease!

Quinine and quinidine are useful in arrhythmias. They will temporarily abolish auricular fibrillation. Quinidine is extremely useful in small doses to prevent auricular fibrillation, extrasystoles, and paroxysmal tachycardia. Its use in angina pectoris tends to prevent secondary sudden death. In the author's clinic the prophylactic use of quinidine has cut down considerably the mortality in such patients. Its action is to depress ectopic pacemakers which can give rise to ventricular fibrillation. Quinidine is also useful in treating paroxysmal tachycardia.

So-called heart hormones are not as valuable as was hoped. They have been most useful in peripheral vascular conditions. In angina their value is problematic. The author uses dextrose solution intravenously in failing hearts in combination with strophanthin but found the sugar solution of no value in angina pectoris and intermittent claudication. In angina pectoris he uses theobromine or sedatives like luminal, or a combination of the two as in theominal. He has found calcium gluconate intramuscularly valuable in angina pectoris and extrasystoles.

He believes in active antisyphilitic therapy, but the arsenicals should be avoided when there is heart-block or angina pectoris, and there is a risk of narrowing the coronary mouths. He uses iodides and bismuth by preference and urges protracted therapy.

L. N. K.

Edens, E.: Action and Indications for Use of Digitalis in Man and Animals. München. med. Wchnschr. **82:** 1670, 1935.

The author states that digitalis action on the work of the heart is the same as the action of hypertrophy except that, unlike hypertrophy, it does not require an increased blood supply. It slows the heart and makes the stroke volume more forceful even against increased resistance and even when there is a decreased filling. The best indication for its use is a hypertrophied failing heart. Here its action is ten- to twentyfold greater than that on a nonhypertrophied heart. This fact makes its action variable depending on where the hypertrophy is. Thus, whether lung edema is associated with left or right ventricular hypertrophy will determine whether the condition is helped or aggravated. In left hypertrophy the lung edema is improved, and in right hypertrophy it is aggravated.

In the clinic digitalis or intravenous strophanthin is always indicated in cardiac irregularities with heart failure. Again, in coronary disease with angina pectoris, the author believes that, contrary to the general belief, digitalis is better than other means provided the heart is hypertrophied.

In general, the author stresses that the use of digitalis and intravenous strophanthin clinically is different from that found in animal experiments.

L. N. K.

Book Reviews

ATLAS OF CONGENITAL CARDIAC DISEASE. By Maude E. Abbott, B.A., M.D., F.R.C.P. (Canada), McGill University, Montreal, Canada. 72 pages containing frontispiece and 25 plates embodying over 200 figures with descriptive text forming a volume 11 × 14 inches, bound in cloth. Published by the American Heart Association, New York, N. Y., August, 1936, price $5.50.

This atlas is "a pictorial retrospect of the author's personal experience" in the field of congenital heart disease. Part I—a small section—deals with the development and comparative anatomy of the heart. The remainder, Part II, entitled "Clinical Classification of Congenital Cardiac Disease," presents the various defects arranged according to Dr. Abbott's classification of (1) acyanotic, (2) cyanose tardive, and (3) cyanotic groups.

Half the space is devoted to illustrations and the remainder is nearly equally divided between brief discussions of the cardiac defects and legends explaining the figures. For example, in the presentation of patent ductus arteriosus, there is a page of text and a page of figures facing each other. The figures include schemata of normal and fetal circulation and that of patent ductus. There are also one x-ray picture, six orthodiagrams, an electrocardiogram, two drawings of the defect and a chart to show the auscultatory findings in detail. Thus, without even turning a page, one has presented clearly all the salient features, in a simple form, easy to remember. This general plan is followed throughout. At the end of the atlas Dr. Abbott's valuable chart, containing statistical data on congenital heart disease, based on an analysis of 1,000 cases, is reproduced.

In this atlas, Dr. Abbott has epitomized her monumental knowledge of congenital cardiac disease and has presented it clearly and simply in the combination of text and superb illustrations. The book is recommended to all with any interest in the subject of heart disease and should be in the library of the general practitioner as well as the specialist. It is destined to become a medical classic.

DISEASES OF THE CORONARY ARTERIES AND CARDIAC PAIN. Edited by Robert L. Levy, M.D., Professor of Clinical Medicine, College of Physicians and Surgeons, Columbia University; Associate Visiting Physician and Cardiologist, Presbyterian Hospital, New York City. Cloth. Price $6, 445 pages, New York, 1936, The Macmillan Company.

This timely and welcome volume represents a praiseworthy effort to present a comprehensive view of the present state of our rapidly growing knowledge of the coronary arteries and their diseases, as well as of the nature and mechanism of cardiac pain.

The book, edited by Dr. Levy, is the product of some fourteen contributors, each of whom is eminently qualified in his special field.

After a thoughtful introduction by A. E. Cohn and an interesting historical note by J. B. Herrick, there follows a detailed and authoritative consideration of the normal coronary circulation. The chapter on the anatomy of the coronary vessels is furnished by J. T. Wearn; those on the physiology and the pharmacology of the coronary circulation, by C. J. Wiggers and F. M. Smith, respectively; that on the pathology of the coronary arteries, by W. C. von Glahn.

The theoretical aspects of cardiac pain are dealt with in two chapters: one by J. C. White on nervous pathways concerned in the mechanism of cardiac pain, and one by C. J. Wiggers on the physiology of cardiac pain.

The remainder of the volume is devoted to the clinical aspects of the subject and to treatment.

The subject of statistics is covered by L. I. Dublin, the subjects of arteriosclerosis (including thrombosis) and of syphilis of the coronary arteries by R. L. Levy, and the subject of the less common affections of the coronary arteries by W. J. Kerr. The chapter on the clinical significance of cardiac pain is written by P. D. White, and that on the electrocardiogram in diseases of the coronary arteries by F. N. Wilson. The subject of medical treatment is dealt with by R. L. Levy.

Some fifty pages of the monograph are given to a consideration of various surgical measures of relief. J. C. White writes authoritatively and sanely concerning paravertebral injections of alcohol, ganglionectomy and posterior rhizotomy for the relief of cardiac pain. It is reassuring to find that he is strongly in favor of the first (and simplest) of these procedures when surgical relief is called for. The subject of total thyroidectomy is discussed by H. L. Blumgart, and the volume is closed with a stimulating account by C. S. Beck of his efforts to provide a new blood supply to the heart by operation.

The book illustrates clearly the many advantages, as well as the minor defects, of such a plan of collaboration.

LES LÉSIONS ORGANIQUES DU COEUR: ÉTUDE CLINIQUE, ANATOMIQUE ET THÉRAPEUTIQUE. By R. Lutembacher. 352 pages with 185 illustrations. Paris, 1936, Masson et Cie.

In this seven-and-a-half-pound volume Professor Lutembacher follows the tradition of the best French clinicians and teachers, binding clinical studies and interpretations to anatomical findings. It is essentially a clinical-pathological study, a book on cardiology generously illustrated with excellent photographs of pathological specimens representing every type of organic heart lesion. It is, however, more than an atlas of morbid anatomy, for there is considerable text with close correlation between the general discussion, the detailed case reports and the illustrations. The illustrations are carefully chosen, reproduced in natural size with explanatory diagrams and are as clear as such black and white figures can be. The text is written by an authority who has had much experience as a teacher and writer. (The bibliography lists five volumes and ninety-five articles by Dr. Lutembacher.) It brings a medical museum of anatomical lesions of the heart to the library. The value of the book will depend largely on the extent to which the reader can picture a pathological process from a black and white photograph.

LECTURES ON EMBOLISM AND OTHER SURGICAL SUBJECTS. By Gunnar Nystrom, M.D., Professor of Surgery, University of Uppsala, Sweden; Chief of the Surgical Clinic and Director of the University Hospital, Uppsala. Published for Vanderbilt University by the Williams and Wilkins Company, Baltimore, 1936.

This small volume contains the five Abraham Flexner lectures on surgical subjects given by the author at the School of Medicine of Vanderbilt University during the past year. Two of these should be of much interest to everyone concerned with cardiovascular problems for they deal in an authoritative way with the surgical management of the embolism of the arteries of the extremities and of that of the pulmonary artery.

ELEMENTS OF ELECTROCARDIOGRAPHIC INTERPRETATION WITH THIRTY-EIGHT PLATES ILLUSTRATING THE MORE IMPORTANT DEVIATIONS FROM THE NORMAL, SELECTED FROM THE FILES OF THE MICHAEL REESE HOSPITAL. By Louis N. Katz, A.M., M.D. Physiologist and Director of Cardiovascular Research, Michael Reese Hospital, Chicago; Assistant Professor of Physiology, University of Chicago; and Victor Johnson, Ph.D., Instructor in Physiology, the University of Chicago. Ed. 2, paper, price $1, the University of Chicago Press, Chicago, Ill.

The purpose of this booklet is to present a brief graphic outline of the more important electrocardiographic deviations from the normal. It is made up of thirty-eight plates, with full descriptive legends, and covers all the more important departures from the normal electrocardiograms. The descriptive legends are clear and easily understood. The booklet provides a concise and authoritative reference atlas for the practicing physician whose chief interests lie outside the field of electrocardiography and for the student beginning the study of cardiac physiology.

WILLIAM WITHERING: THE INTRODUCTION OF DIGITALIS INTO MEDICAL PRACTICE. By Louis H. Roddis, M.D., Commander, Medical Corps, United States Navy. 131 pages, 8 illustrations. Paul B. Hoeber, Inc. Medical Book Department of Harper & Brothers, New York, 1936.

The life and work of William Withering deserve more general appreciation and understanding of the medical profession than they have hitherto received.

This pleasantly written little volume merits a wide welcome, therefore, as making readily available the essential features of both the life and the work of a truly great physician.

Like so many other great English physicians of his period Withering won distinction in fields other than that of medicine. He would have been known as a distinguished botanist and mineralogist if his contributions to these sciences had not been overshadowed by his reputation as a practitioner and as the discoverer of the value of digitalis in medicine.

In reading his own statements as to the indications for the use of the drug, its method of administration, its limitations, and its possible dangers, one can but be amazed that so complete and so accurate an understanding of the drug should have been derived merely from the clinical observations of a single man.

"In spite of opinion, prejudice, or error, Time will fix the real value upon the discovery and determine whether I have imposed upon myself and others or contributed to the benefit of science and mankind." Time has spoken in no uncertain voice.

LA PRESSION MOYENNE DE L'HOMME A L'ÉTAT NORMAL ET PATHOLOGIQUE. By H. Vaquez and P. Gley. Masson et Cie., Paris, 1936. 126 pages with 57 figures. Price, 25 francs.

Believing that a proper understanding of the blood pressure can never be obtained from a study of the maximum and minimum pressures only, the authors have devoted much time and study to the mean arterial tension. They believe that the study of the mean arterial tension is important clinically as well as experimentally. They discuss the mean tension under normal and abnormal conditions and describe a syndrome, "hypertension moyenne solitaire." The greater part of the book is given over to a discussion of methods and tracings, the latter part to clinical applications.

Books Received

ESTUDIO FUNCIONAL DEL HIGADO AFECTADO POR EL ESTANCAMIENTO SANGUINEO EN LAS CARDIOPATIAS. Severo R. Amuchastegui. 166 pages, imprenta de las Universidad Nacional de Cordoba, 1936.